This is a Class 1 exam

Lebanon Evangelical School
for Boys and Girls
Loueizeh - Baabda

Stage Exam 04
27MAR2023

Do NOT write in this box. Your MARK will be placed here.

Subject :	Physics
Class :	10A
Teacher :	Dr Ruth Brett
Duration :	1 hour

There are some formulae on the last page which you may (or may not) find useful.

Your name :		*Time taken to complete exam*
Your Class :		
Exam Room :		
How many sheets, including cover sheet :		

- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

Q1. The passage describes some of the properties of magnets and magnetic fields.

Use words from the box to complete the passage.

aluminium	copper	hard	negative	
north	positive	soft	south	steel

Each word may be used once, more than once or not at all.

(5)

The north pole of one magnet will repel the ..... pole of another magnet.

There is attraction between ..... and magnets.

Materials that are difficult to magnetise are called ..... magnetic materials.

The direction of the magnetic field lines for a magnet is from ..... to south.

Iron is a ..... magnetic material.

(Total for question = 5 marks)

Q2. This question is about electromagnetism.

(a) Diagram 1 shows the construction of an electromagnet.

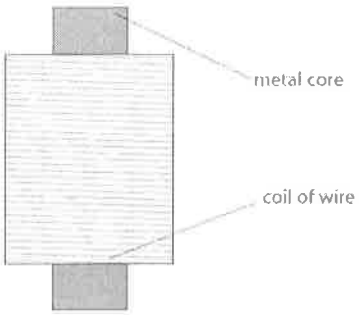


Diagram 1

Name a suitable metal for the core.

(1)

.....

(b) Electromagnets are used in transformers to change the size of a voltage. Diagram 2 shows the construction of a simple transformer.

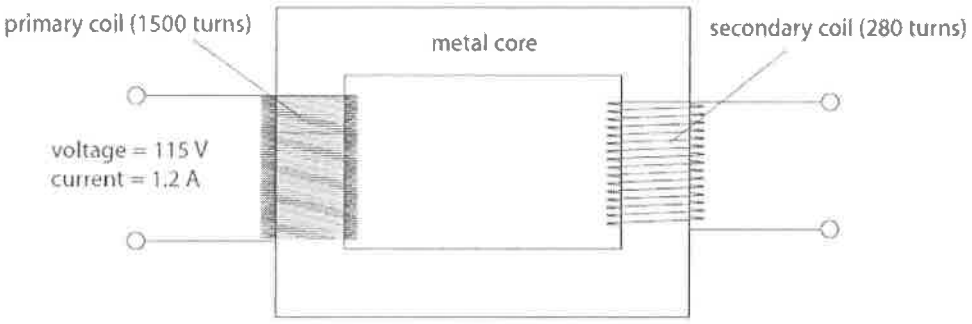


Diagram 2

(i) State the formula linking the input (primary) voltage, output (secondary) voltage and the turns ratio for a transformer.

(1)

(ii) The input voltage to the transformer is 115 V.
Show that the output voltage is approximately 20 V.

(3)

(iii) The input current to the transformer is 1.2 A.
Calculate the output current.
Assume that the transformer is 100% efficient.

(3)

output current = ... A

(Total for question = 8 marks)

Q3. This question is about bar magnets.

(a) Describe an investigation to show the shape and direction of the magnetic field for a bar magnet.

You may draw a diagram to help your answer.

(3)

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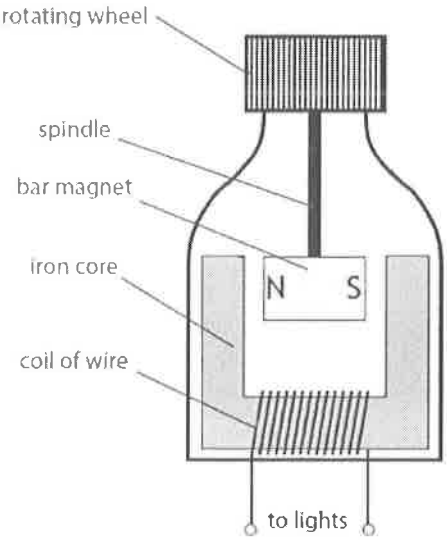
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(b) A bar magnet is used in a bicycle dynamo.

The diagram shows a cross-section of a bicycle dynamo.



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The dynamo has a rotating wheel that presses against the tyre of the bicycle.
The rotating wheel is connected to a bar magnet by a spindle.
When the rotating wheel spins, the bar magnet spins.

(i) The dynamo is connected to the lights on the bicycle.
Explain how the dynamo causes the lights to turn on when the bicycle is moving.

(4)

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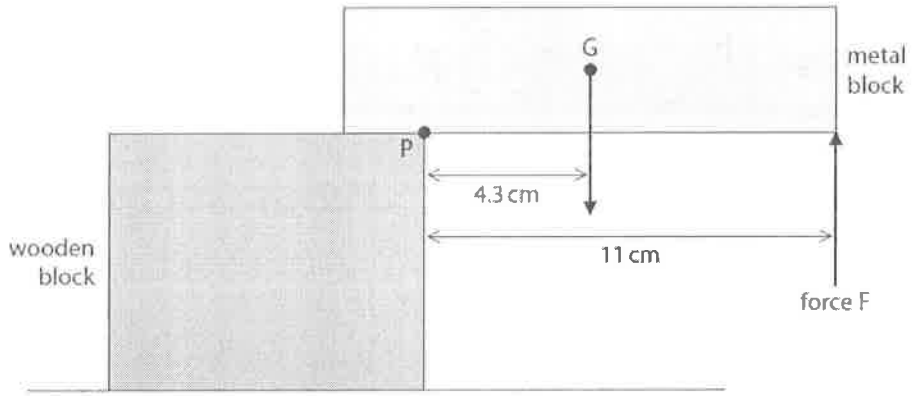
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(Total for question = 7 marks)

Q4. The diagram shows a metal block on top of a wooden block. The metal block is held stationary by force F.



(a) (i) The weight of the metal block acts through point G.

Give the name of point G.

(1)

.....

(ii) Name a piece of apparatus that could be used to measure the weight of the metal block.

(1)

.....

(b) (i) State the formula linking moment, force and perpendicular distance from the pivot.

(1)

(ii) The weight of the metal block is 0.68 N.
Show that the moment of the weight of the metal block about point P is approximately 2.9 N cm.

(1)

(iii) Force F is applied to the metal block to stop it from moving.
Calculate the magnitude of force F.

(3)

force F = ... N

(Total for question = 7 marks)

Q5. Curling is a sport played on ice.

A player slides stone A across the ice towards a scoring zone.

The ice reduces friction so that there is negligible friction when the stone is sliding.



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(a) Stone A leaves the player's hand with a velocity of 2.90 m/s.

The mass of stone A is 17 kg.

(i) State the formula linking momentum, mass and velocity.

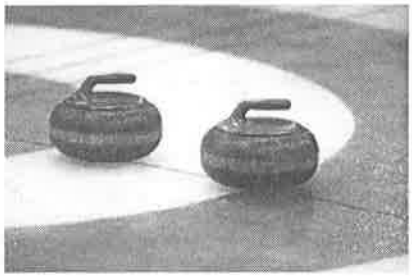
(1)

(ii) Show that the momentum of stone A is approximately 50 kg m/s.

(2)

(b) Stone A slides towards the scoring zone.

In the scoring zone, stone A collides with a stationary stone, B.



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(i) After the collision, both stones move in the same direction as the initial direction of stone A.
The velocity of stone A after the collision is 0.40 m/s.
Calculate the velocity of stone B after the collision.
[mass of stone B = 19 kg]

(4)

velocity of stone B = ... m/s

(ii) When the stones collided, they were in contact for a time of 25 ms.
Calculate the magnitude of the force stone A exerted on stone B in this collision.

(3)

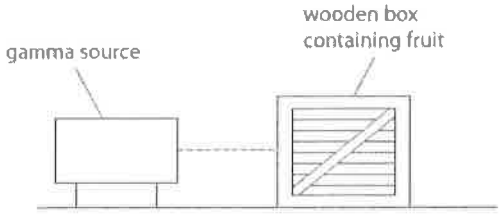
force = ... N

(Total for question = 10 marks)

Q6. This question is about food preservation.

(a) The diagram shows how gamma radiation is used to irradiate fruit stored in a wooden box.

The radiation kills bacteria on the fruit.



Explain why gamma radiation is used instead of alpha radiation to kill bacteria.

(2)

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(b) The wooden box has this label.

these fruits
have been
irradiated

Explain why fruit irradiated with gamma radiation is safe to eat.

(2)

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(Total for question = 4 marks)

Q7. Cobalt-60 is a radioactive isotope of cobalt.

The table gives the activity of a sample of cobalt-60 over a period of 10 years.

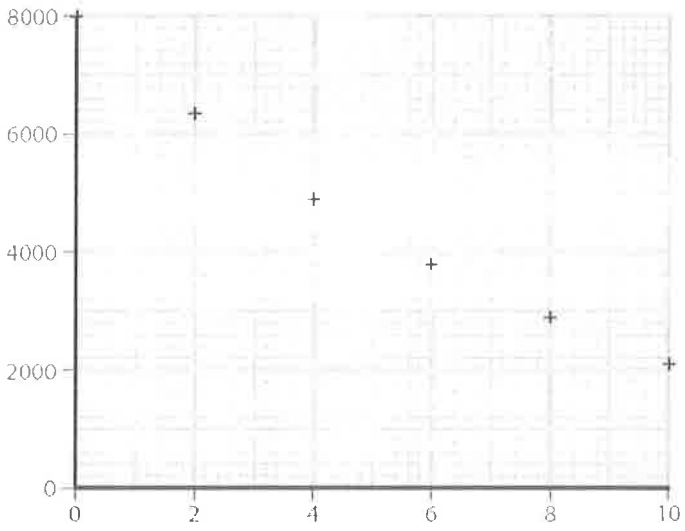
Time in years	Activity
0	8000
2	6350
4	4900
6	3800
8	2900
10	2100

(a) Give a suitable unit for activity.

(1)

.....

(b) The graph shows the data.



(i) Label both axes.

(1)

(ii) Draw the curve of best fit.

(1)

(iii) Use the graph to determine the half-life of cobalt-60.

(2)

half-life = ... years

(iv) Estimate the time taken for the activity to decrease to $\frac{1}{8}$ of its initial value.

(2)

time = ... years

(c) Cobalt-60 is produced when a neutron is absorbed by the nucleus of a stable atom of cobalt-59.

The nuclei of these two isotopes can be represented as

$^{60}_{27}Co$ $^{59}_{27}Co$

Describe a similarity and a difference for the nuclei of these two isotopes of cobalt.

(2)

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.....

(d) Cobalt-60 decays by beta emission.

Describe what happens to the nucleus of a cobalt-60 atom during beta decay.

(2)

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.....

(Total for question = 11 marks)

Q8. (a) Uranium-235 captures a neutron and undergoes nuclear fission in a chain reaction.
The equation shows a possible nuclear fission reaction.

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{97}_{40}Zr + ^{135}_{52}Te + x\,^{1}_{0}n$$

Calculate x, the number of neutrons released by this fission reaction.

(2)

x = ...

(b) Describe what is meant by a **chain reaction**.

(3)

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(c) Iodine-129 is an isotope found in radioactive waste from nuclear power stations.

Iodine-129 has a half-life of approximately 15 million years.
A sample of iodine-129 has an activity of 72 kBq.
Show that the time required for the sample to have an activity less than 5 kBq is approximately 60 million years.

(3)

(Total for question = 8 marks)

FORMULAE

You may find the following formulae useful.

energy transferred = current × voltage × time $E = I \times V \times t$

$$\text{frequency} = \frac{1}{\text{time period}} \qquad f = \frac{1}{T}$$

$$\text{power} = \frac{\text{work done}}{\text{time taken}} \qquad P = \frac{W}{t}$$

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}} \qquad P = \frac{W}{t}$$

$$\text{orbital speed} = \frac{2\pi \times \text{orbital radius}}{\text{time period}} \qquad v = \frac{2 \times \pi \times r}{T}$$

(final speed)^2 = (initial speed)^2 + (2 × acceleration × distance moved)

$$v^2 = u^2 + (2 \times a \times s)$$

pressure × volume = constant $p_1 \times V_1 = p_2 \times V_2$

$$\frac{\text{pressure}}{\text{temperature}} = \text{constant} \qquad \frac{p_1}{T_1} = \frac{p_2}{T_2}$$

$$\text{force} = \frac{\text{change in momentum}}{\text{time taken}} \qquad F = \frac{(mv - mu)}{t}$$

$$\frac{\text{change of wavelength}}{\text{wavelength}} = \frac{\text{velocity of a galaxy}}{\text{speed of light}} \qquad \frac{\lambda - \lambda_0}{\lambda_0} = \frac{\Delta\lambda}{\lambda_0} = \frac{v}{c}$$

change in thermal energy = mass × specific heat capacity × change in temperature

$$\Delta Q = m \times c \times \Delta T$$

Where necessary, assume the acceleration of free fall, $g = 10\ \text{m/s}^2$.

Q1. The passage describes some of the properties of magnets and magnetic fields.

Use words from the box to complete the passage.

aluminium	copper	hard	negative	
north	positive	soft	south	steel

Each word may be used once, more than once or not at all.

(5)

The north pole of one magnet will repel the .....north..... (1) pole of another magnet.

There is attraction between .....steel..... (1) and magnets.

Materials that are difficult to magnetise are called .....hard..... (1) magnetic materials.

The direction of the magnetic field lines for a magnet is from .....north..... (1) to south.

Iron is a .....soft..... (1) magnetic material.

(Total for question = 5 marks)

Q2. This question is about electromagnetism.

(a) Diagram 1 shows the construction of an electromagnet.

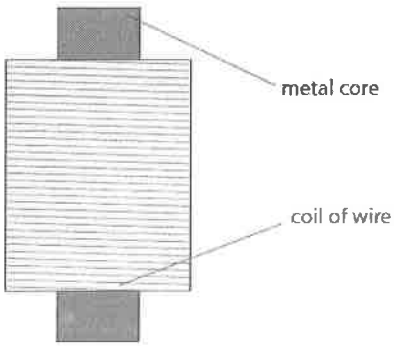


Diagram 1

Name a suitable metal for the core.

(1)

.....Soft iron..... (1)

(b) Electromagnets are used in transformers to change the size of a voltage. Diagram 2 shows the construction of a simple transformer.

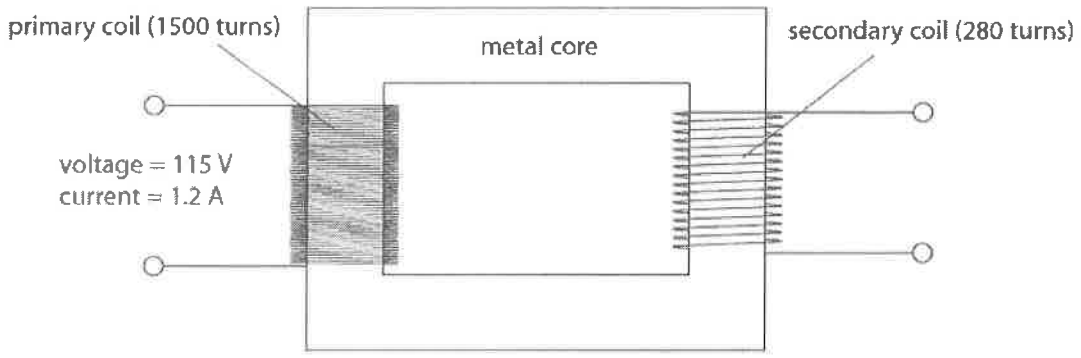


Diagram 2

(i) State the formula linking the input (primary) voltage, output (secondary) voltage and the turns ratio for a transformer.

(1)

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$ (1)

(ii) The input voltage to the transformer is 115 V.
Show that the output voltage is approximately 20 V.

(3)

$$\frac{115}{V_s} = \frac{1500}{280}$$ (1)

$$V_s = \frac{115 \times 280}{1500} = 21.46\dot{6}$$ (1)

$$V_s = 21.5\,V$$ (1)

(iii) The input current to the transformer is 1.2 A.
Calculate the output current.
Assume that the transformer is 100% efficient.

(3)

If 100% efficient, input power = output power (1)

power = V x I

$115 \times 1.2 = 21.5 \times I$ (1)

$I = \frac{115 \times 1.2}{21.5} = 6.4\,A$

output current = 6.4 (1) A

(Total for question = 8 marks)

Q3. This question is about bar magnets.

(a) Describe an investigation to show the shape and direction of the magnetic field for a bar magnet.

You may draw a diagram to help your answer.

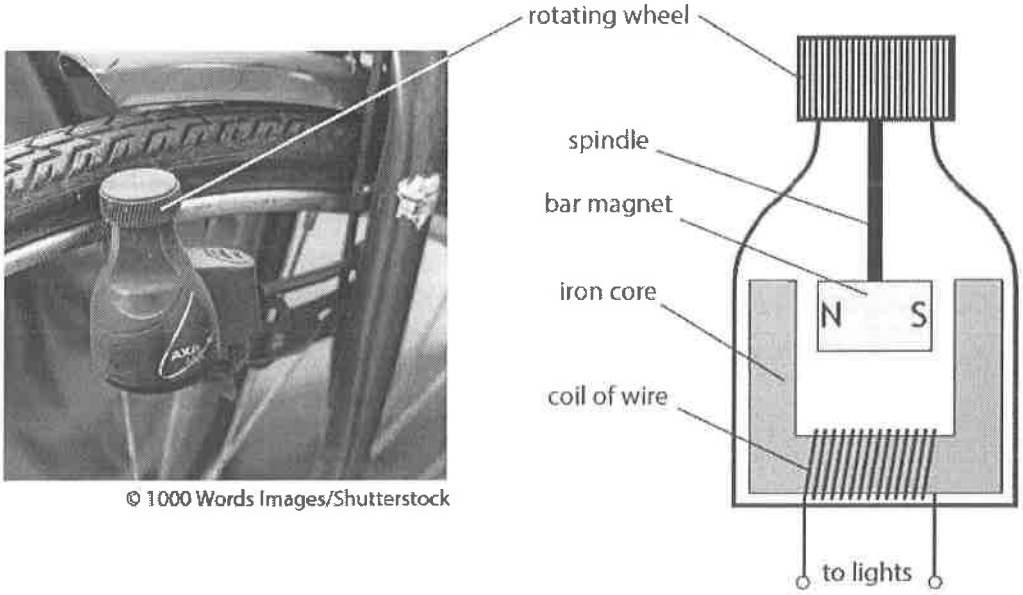
(3)

Draw round a magnet on a piece of paper and place a plotting compass (1) near one end. Mark both ends of the arrow, then move the compass (1) so the tail of the arrow is now on the mark where the tip of the arrow was. Mark the new position of the tip of the arrow and repeat until the compass reaches the other pole of the magnet.

Join the dots to show the shape of the magnetic field and add an arrow (1) to show the direction of the magnetic field as shown by the compass.

(b) A bar magnet is used in a bicycle dynamo.

The diagram shows a cross-section of a bicycle dynamo.



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The dynamo has a rotating wheel that presses against the tyre of the bicycle.
The rotating wheel is connected to a bar magnet by a spindle.
When the rotating wheel spins, the bar magnet spins.

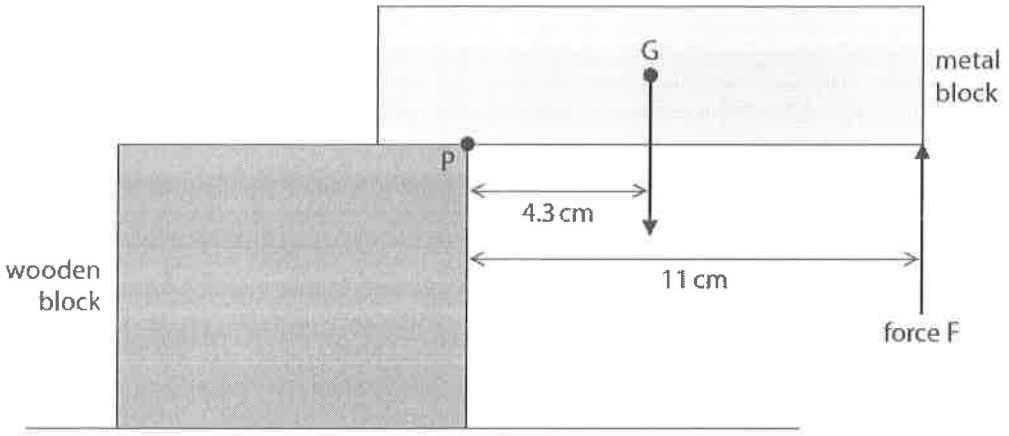
(i) The dynamo is connected to the lights on the bicycle.
Explain how the dynamo causes the lights to turn on when the bicycle is moving.

(4)

The bar magnet causes the iron core to become magnetic (1)
When the bar magnet spins, the magnetic field lines
move / change (1) which means the field lines ~~cut~~ are cut
by the wire of the coil (1). This induces a voltage (1) across
the coil causing a current (1) in the wire so the lights
will turn on. alternative mark

(Total for question = 7 marks)

Q4. The diagram shows a metal block on top of a wooden block. The metal block is held stationary by force F.



(a) (i) The weight of the metal block acts through point G.

Give the name of point G.

(1)

Centre of mass (gravity) (1)

(ii) Name a piece of apparatus that could be used to measure the weight of the metal block.

(1)

newtonmeter (1) / spring balance

(b) (i) State the formula linking moment, force and perpendicular distance from the pivot.

(1)

moment = force x perpendicular distance from the pivot (1)

(ii) The weight of the metal block is 0.68 N.

Show that the moment of the weight of the metal block about point P is approximately 2.9 N cm.

(1)

moment = $0.68 \times 4.3 = 2.924$ Ncm (1)

(iii) Force F is applied to the metal block to stop it from moving.

Calculate the magnitude of force F.

(3)

clockwise moment = anticlockwise moment (1)

$2.924 = F \times 11$ (1)

$F = \frac{2.924}{11} = 0.266$

(1)

force F = 0.266 N

(Total for question = 7 marks)

Q5. Curling is a sport played on ice.

A player slides stone A across the ice towards a scoring zone.

The ice reduces friction so that there is negligible friction when the stone is sliding.



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(a) Stone A leaves the player's hand with a velocity of 2.90 m/s.

The mass of stone A is 17 kg.

(i) State the formula linking momentum, mass and velocity.

(1)

momentum = mass x velocity (1)

(ii) Show that the momentum of stone A is approximately 50 kg m/s.

(2)

momentum = 17 x 2·9 = 49·3 kg m/s

(1) (1)

(b) Stone A slides towards the scoring zone.

In the scoring zone, stone A collides with a stationary stone, B.



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(i) After the collision, both stones move in the same direction as the initial direction of stone A.
The velocity of stone A after the collision is 0.40 m/s.
Calculate the velocity of stone B after the collision.
[mass of stone B = 19 kg]

(4)

total momentum before collision = total momentum after collision (1)

$49 \cdot 3 = (17 \times 0 \cdot 4) + (19 \times v_B)$

(from (a)) (momentum of A) (momentum of B)

$49 \cdot 3 = 6 \cdot 8 + 19v_B$ (1)

$19v_B = 42 \cdot 5$

$v_B = \frac{42 \cdot 5}{19} = 2 \cdot 24$ (1)

velocity of stone B = 2·24 (1) m/s

(ii) When the stones collided, they were in contact for a time of 25 ms.
Calculate the magnitude of the force stone A exerted on stone B in this collision.

(3)

$\text{force} = \frac{\text{change in momentum}}{\text{time}}$

25 ms ÷1000 → 0·025 s (1)

$F = \frac{49 \cdot 3 - 6 \cdot 8}{0 \cdot 025} = \frac{42 \cdot 5}{0 \cdot 025} = 1700$ (1)

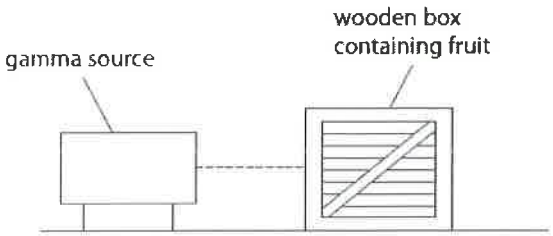
force = 1700 (1) N

(Total for question = 10 marks)

Q6. This question is about food preservation.

(a) The diagram shows how gamma radiation is used to irradiate fruit stored in a wooden box.

The radiation kills bacteria on the fruit.

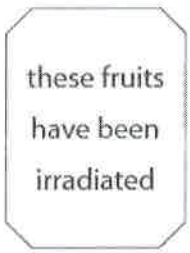


Explain why gamma radiation is used instead of alpha radiation to kill bacteria.

(2)

Gamma is more penetrating (1) than alpha, so gamma can pass through the box (1) but alpha couldn't.

(b) The wooden box has this label.



Explain why fruit irradiated with gamma radiation is safe to eat.

(2)

The gamma radiation kills any bacteria (1) on the fruit, but the fruit is not radioactive (1) so it is safe to eat.

or fruit is not contaminated (1)

(Total for question = 4 marks)

Q7. Cobalt-60 is a radioactive isotope of cobalt.

The table gives the activity of a sample of cobalt-60 over a period of 10 years.

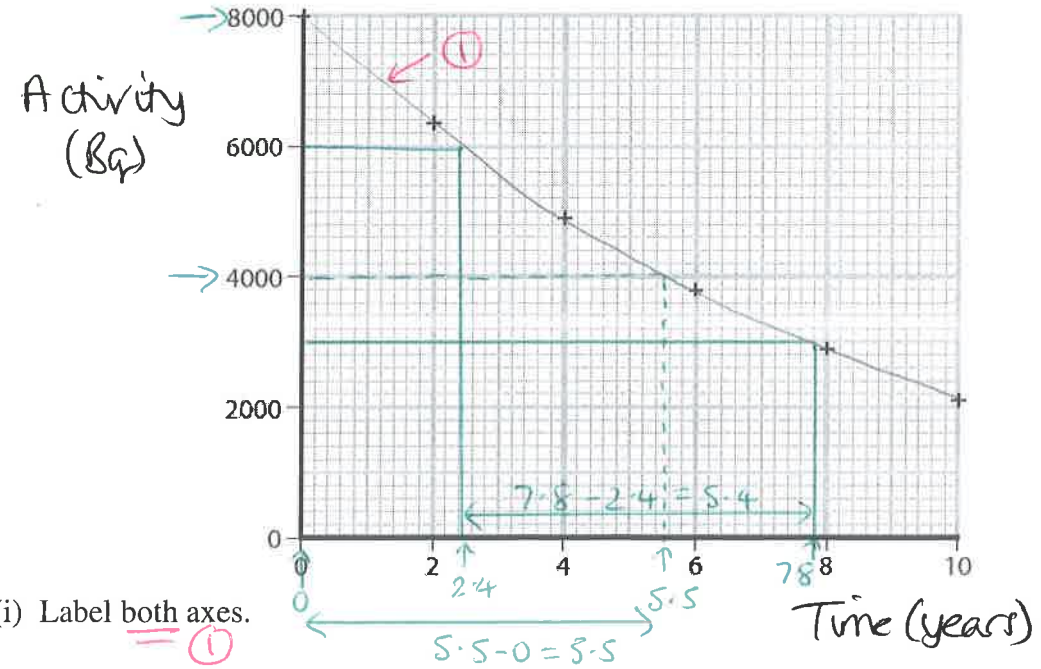
Time in years	Activity
0	8000
2	6350
4	4900
6	3800
8	2900
10	2100

(a) Give a suitable unit for activity.

becquerels (1)

(1)

(b) The graph shows the data.



(i) Label both axes. (1)

(1)

(ii) Draw the curve of best fit.

(1)

(iii) Use the graph to determine the half-life of cobalt-60. Working seen (1)

$$\text{average half-life} = \frac{5\cdot5 + 5\cdot4}{2} = 5\cdot45$$

(2)

half-life = 5·45 (1) years

(iv) Estimate the time taken for the activity to decrease to $\frac{1}{8}$ of its initial value.

(2)

3 half-lives needed (1)

3 x 5·45 = 16·35 years

time = 16·4 (1) years

(c) Cobalt-60 is produced when a neutron is absorbed by the nucleus of a stable atom of cobalt-59.

The nuclei of these two isotopes can be represented as

$^{60}_{27}Co$ $^{59}_{27}Co$

Describe a similarity and a difference for the nuclei of these two isotopes of cobalt.

(2)

Same number of protons (1)

Co-60 has one more neutron (1)

(d) Cobalt-60 decays by beta emission.

Describe what happens to the nucleus of a cobalt-60 atom during beta decay.

(2)

The nucleus loses a neutron (1) and gains a proton (1)

(Total for question = 11 marks)

Q8. (a) Uranium-235 captures a neutron and undergoes nuclear fission in a chain reaction.
The equation shows a possible nuclear fission reaction.

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{97}_{40}Zr + ^{135}_{52}Te + x\,^{1}_{0}n$$

Calculate x, the number of neutrons released by this fission reaction.

(2)

LHS = RHS

$235 + 1 = 97 + 135 + x(1)$ (1)

$236 = 232 + x$

$x = 236 - 232 = 4$

x = 4 (1)

(b) Describe what is meant by a **chain reaction**.

(3)

A fission reaction produces neutrons (1) which can then be absorbed (1) by uranium nuclei, which will then undergo fission (1) producing more neutrons.

(c) Iodine-129 is an isotope found in radioactive waste from nuclear power stations.

Iodine-129 has a half-life of approximately 15 million years.
A sample of iodine-129 has an activity of 72 kBq.
Show that the time required for the sample to have an activity less than 5 kBq is approximately 60 million years.

(3)

$\frac{72}{2} = 36$ 1 half-life $\frac{36}{2} = 18$ 2 half-lives $\frac{18}{2} = 9$ 3 half-lives

(halving) (1)

$\frac{9}{2} = 4.5 \Rightarrow$ 4 half-lives for A to be less than 5kBq (1)

4×15 million = 60 million years (1)

(Total for question = 8 marks)

FORMULAE

You may find the following formulae useful.

energy transferred = current × voltage × time $E = I \times V \times t$

$$\text{frequency} = \frac{1}{\text{time period}} \qquad f = \frac{1}{T}$$

$$\text{power} = \frac{\text{work done}}{\text{time taken}} \qquad P = \frac{W}{t}$$

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}} \qquad P = \frac{W}{t}$$

$$\text{orbital speed} = \frac{2\pi \times \text{orbital radius}}{\text{time period}} \qquad v = \frac{2 \times \pi \times r}{T}$$

(final speed)^2 = (initial speed)^2 + (2 × acceleration × distance moved)

$$v^2 = u^2 + (2 \times a \times s)$$

pressure × volume = constant $p_1 \times V_1 = p_2 \times V_2$

$$\frac{\text{pressure}}{\text{temperature}} = \text{constant} \qquad \frac{p_1}{T_1} = \frac{p_2}{T_2}$$

$$\text{force} = \frac{\text{change in momentum}}{\text{time taken}} \qquad F = \frac{(mv - mu)}{t}$$

$$\frac{\text{change of wavelength}}{\text{wavelength}} = \frac{\text{velocity of a galaxy}}{\text{speed of light}} \qquad \frac{\lambda - \lambda_0}{\lambda_0} = \frac{\Delta\lambda}{\lambda_0} = \frac{v}{c}$$

change in thermal energy = mass × specific heat capacity × change in temperature

$$\Delta Q = m \times c \times \Delta T$$

Where necessary, assume the acceleration of free fall, g = 10 m/s^2.