A-Level Edexcel

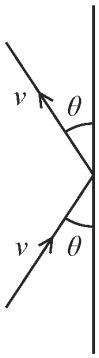
PHYSICS

UNIT 4(IAL)

2020 — 2023

1 – (WPH11/4(IAL)_Summer_2020_Q5) – *Further Mechanics*

A gas molecule of mass m travelling at speed v strikes the side of a gas cylinder at an angle θ. The collision takes time t.



What is the average force acting on the side of the gas cylinder?

☒ **A** $\frac{mv}{t}$

☒ **B** $\frac{2mv}{t}$

☒ **C** $\frac{mv\sin\theta}{t}$

☒ **D** $\frac{2mv\sin\theta}{t}$

2 – (WPH11/4(IAL)_Summer_2020_Q9) – *Further Mechanics*

A turntable for playing vinyl records rotates at 33 revolutions per minute.

What is the angular velocity in radian s^{-1}?

☒ **A** $33 \times 60 \times 2\pi$

☒ **B** $\dfrac{33}{(60 \times 2\pi)}$

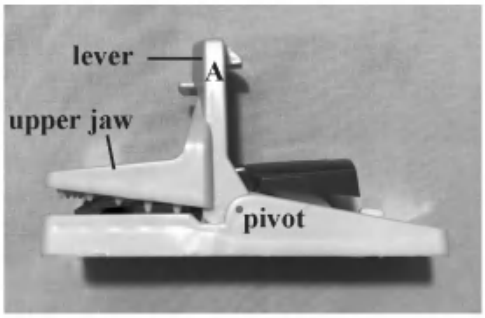
☒ **C** $\left(\dfrac{33}{60}\right) \times 2\pi$

☒ **D** $33 \times 2\pi$

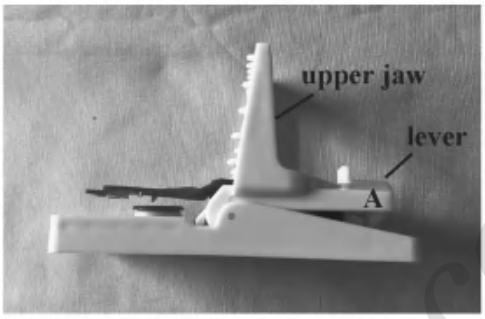
3 – (WPH11/4(IAL)_Summer_2020_Q15) – *Further Mechanics*

A student carried out an investigation to compare the energy stored in a mechanical mouse trap with the energy stored in an electronic mouse trap.

(a) The photographs show the mechanical version trap before and after it is set to trap a mouse.



Before being set



After being set

The trap was set by applying a force on the lever at point A. The lever rotated through an angle of 90°, stretching a spring. The force was applied at right angles to the lever throughout the process.

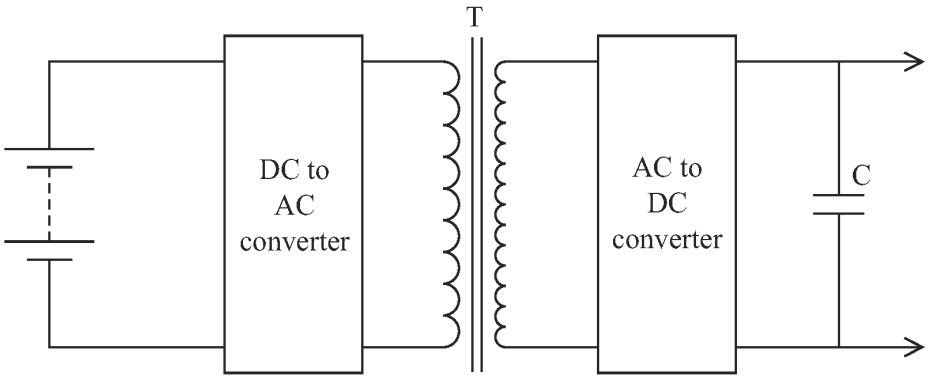
The initial force applied was 2.6 N and the force increased steadily to a final value of 9.6 N when the trap was set.

Show that the work done setting the trap was about 0.5 J.

length of lever = 4.9 cm

(2)

(b) The electronic mouse trap works by applying a large potential difference (p.d.) across two metal plates. The diagram shows part of the circuit for the electronic mouse trap.

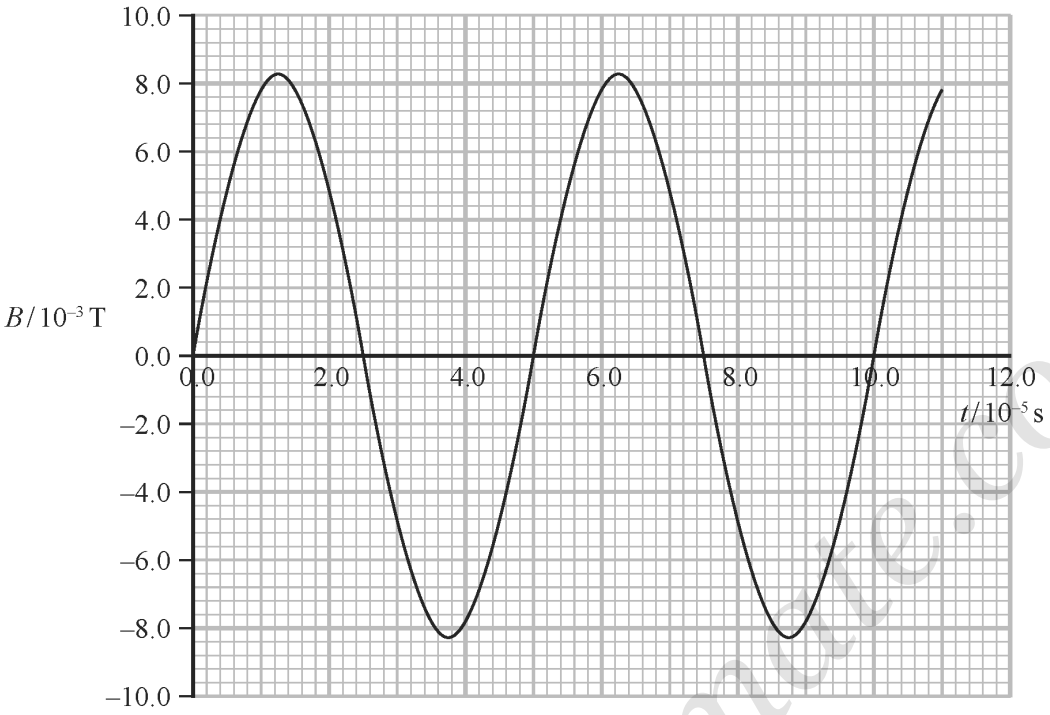


*(i) The transformer T consists of two coils wound around a single iron core. An alternating p.d. is applied to the input coil and the output coil is connected, through a diode, to a capacitor.

Explain how applying a p.d. across the input coil causes the capacitor to charge.

(6)

(ii) The graph shows how the magnetic flux density B in the iron core varies with time.



Show that the maximum p.d. across the output coil is about 600 V.

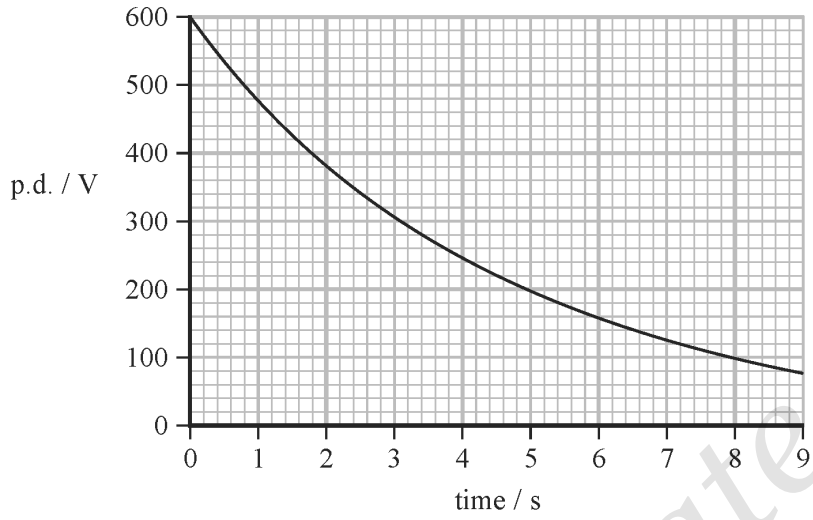
number of turns on coil = 1700

cross-sectional area of coil = 3.5×10^{-4} m^2

(3)

(c) The student tested the capacitor by charging it until the p.d. across the capacitor was 600 V and recording the p.d. as it was discharged through a resistor of resistance 3000 Ω.

The following graph was obtained.

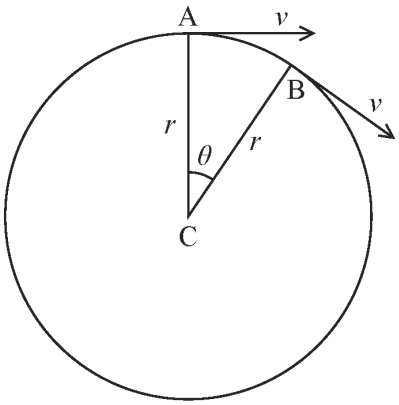


Determine whether the mechanical or the electric mouse trap stores the most energy.

(5)

4 – (WPH11/4(IAL)_Summer_2020_Q16) – *Further Mechanics*

(a) An object travels with speed v around a circular path or radius r. The diagram shows two positions, A and B on the path.



The acceleration of the object is a.

Derive the expression $a = \frac{v^2}{R}$

You should include a vector diagram.

(4)

(b) The photograph shows a toy with small aeroplanes suspended from a canopy by wires.

As the platform rotates, the aeroplanes rise and follow a circular path.

At a particular speed, the aeroplanes follow a circular path of diameter 10.8 cm and the wires make an angle of 19° to the vertical.

(i) Complete a free body force diagram for one of the aeroplanes at this speed.

(1)

(ii) Show that, at this speed, the time for an aeroplane to make 4 complete rotations is about 3 s.

mass of aeroplane = 5.2 g

(4)

(iii) Student A suggests that if the radius of the canopy was increased and rotated at the same angular velocity as before, the wires supporting the aeroplanes could be vertical.

Student B suggests that the wires would be at an angle of greater than 19° to the vertical.

Explain whether either of the students is correct.

(5)

ANSWERS

1 – (WPH11/4(IAL)_Summer_2020_Q5) – *Further Mechanics*

	D The only correct answer is **D** because the component of momentum perpendicular to the surface is $mv\sin\theta$ so the change in momentum is $2mv\sin\theta$ and the time is t and force = change in momentum divided by time A is not the correct answer because it does not take account of the angle B is not the correct answer because it does not take account of the angle C is not the correct answer because it is only half of the correct value	**(1)**

2 – (WPH11/4(IAL)_Summer_2020_Q9) – *Further Mechanics*

	C The only correct answer is **C** because angular velocity = angular displacement / time, which is 33 revolutions multiplied by 2 π radians divided by 60 seconds A is not the correct answer because it is not $33 \times 2\pi / 60$ B is not the correct answer because it is not $33 \times 2\pi / 60$ D is not the correct answer because it is not $33 \times 2\pi / 60$	**(1)**

3 – (WPH11/4(IAL)_Summer_2020_Q15) – *Further Mechanics*

<table>
<tr>
<td>(a)</td>
<td>
• Use of $W = F_{ave} \times x$ (1)
• $W = 0.47$ J (1)

<u>Example of calculation</u>
$W = 0.5(2.6\text{ N} + 9.6\text{ N}) \times 0.5 \times \pi \times 0.049\text{ m}$
$W = 0.47$ J
</td>
<td>2</td>
</tr>
<tr>
<td>* (b) (i)</td>
<td>
This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.

<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th><th>Max linkage mark available</th><th>Max final mark</th></tr>
<tr><td>6</td><td>4</td><td>2</td><td>6</td></tr>
<tr><td>5</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>4</td></tr>
<tr><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>2</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
The following table shows how the marks should be awarded for structure and lines of reasoning.
</td>
<td>6</td>
</tr>
</table>

	<table><tr><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></tr><tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr><tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr><tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr></table> Guidance on how the mark scheme should be applied: The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points which is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning). If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages). Indicative content: • (Aternating p.d. produces) alternating current in input coil • (Alternating/varying current produces) a varying magnetic field in core **Or** (Alternating/varying current produces) a varying magnetic field in second coil • There is a change in magnetic flux linkage with (second) coil • E.m.f. induced • Complete circuit, so current in capacitor circuit • Diode produces direct current	
(b)(ii)	• Evidence of attempt to determine maximum gradient of graph **(1)** • Use of emf = NA dB/dt • Max emf = 610 V **(1)** **(1)** Example of calculation Gradient = 1030 T s^{-1} Emf = 1030 T s^{-1} × 1700 × 3.5 × 10^{-4} m^2 = 613 V	**3**
(c)	• Calculate V_0 / e **(1)** • Read time constant from graph = (4.5 s) **(1)** • Use of time constant = RC **(1)** • Use of W = ½ CV^2 **(1)** • W = 270 J which is greater than 0.47 J, so the electrical method stores the most energy **(1)** **OR** • Draws tangent to line at t = 0 s	**5**

	• Read time constant value off graph (= 4.5 s) • Use of time constant = RC • Use of $W = ½ CV^2$ • W = 270 J which is greater than 0.47 J, so the electrical method stores the most energy **OR** • record a pair of values of V and t from graph • Use of $V = V_0 e^{-\frac{t}{RC}}$ • Convert to correct logarithmic form • Use of $W = ½ CV^2$ • W = 270 J which is greater than 0.47 J, so the electrical method stores the most energy **OR** • $V_0 / 2 = V_0 e^{-t_{½}/RC}$ • $RC = t_{½} / \ln 2$ • Records time for V to decrease to ½ (= 3.1 s) • Use of $W = ½ CV^2$ • W = 270 J which is greater than 0.47 J, so the electrical method stores the most energy <u>Example of calculation</u> V_0 / e = 600 V / e = 221 V Time constant = 4.5 s 4.5 s = 3000 Ω × C $C = 1.5 \times 10^{-3}$ F $W = ½ \times 1.5 \times 10^{-3}$ F × (600 V)^2 = 270 J	