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*5205612338*

**PHYSICS** **0625/43**

Paper 4 Theory (Extended) **May/June 2022**

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

**INSTRUCTIONS**

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.
- Take the weight of 1.0 kg to be 10 N (acceleration of free fall = $10\,m/s^2$).

**INFORMATION**

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

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**[Turn over**

**1** A battery provides energy to an electric car.

**(a)** The electric car has an acceleration of 2.9 m/s$^2$ when it moves from rest.
The combined mass of the car and its driver is 1600 kg.

$u = 0$, $a = 2.9\,m/s^2$, $t = ?$, $v = 28\,m/s$

**(i)** Calculate the time taken to reach a speed of 28 m/s.

$t \times a = \frac{v-u}{t} \times t$

$t = \frac{v-u}{a} = \frac{28-0}{2.9} = 9.655\,s$

$t = 9.7\,s$

time = ........ 9.7 s ........ [2]

**(ii)** Calculate the force required to produce this acceleration.

$F = m \times a = 1600\,kg \times 2.9\,m/s^2 = 4640\,N \approx 4600\,N$

force = ........ 4600 N ........ [2]

**(iii)** Calculate the kinetic energy of the car when its speed is 28 m/s.

$K.E = \frac{1}{2} \times m \times v^2 = \frac{1}{2} \times 1600 \times 28^2 = 800 \times 28^2 = 627{,}200\,J = 630{,}000\,J$

kinetic energy = ........ 630,000 J. ........ [2]

**(b)** The time taken for the car battery to be recharged from zero charge to full charge is 8.3 h.
The charge is delivered to the battery by a charger with a current of 32 A.

Calculate the charge supplied by the charger.

1 h = 60 minutes = 60 × 60 = 3600 s

$Q = I \times t$

$= 32 \times 8.3 \times 3600$

$= 956{,}160\,C$

$= 960{,}000\,C$

charge = ........ 960,000 C ........ [3]

**(c)** Under ideal conditions, the car can travel a maximum distance of 390 km when the battery is fully charged.

Suggest why, in normal use, the car needs to be recharged after travelling less than 390 km.

– Reapeted acceleration and decelations and different road condition, with air resistance
........................................................................ [1]

[Total: 10]

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**2** Water is held behind a dam in a hydroelectric power scheme.

**(a)** State the main form of energy stored in the water behind the dam.

g.p.e ........................................................................................ [1]

**(b)** The water is released from the dam and falls a vertical height of 410 m at a rate of 480 kg/s.

**(i)** Calculate the rate at which energy is transferred by the falling water.

w = mg = 480 × 10 = 4800 N

1 W = J/s
1 J = Nm

P = E/t = F × d / t
= 4800 N × 410 m / 1 s
= 1968,000 W
= 2,000,000 W
= 2.0 × 10⁶ W

rate of energy transfer = ......... 2.0 × 10⁶ W ......... [3]

**(ii)** The power scheme supplies a current of 270 A at a voltage of 6000 V.

Calculate the efficiency of the power scheme.

P = V × I
= 6000 V × 270 A
= 1,620,000 W

E = Useful Power out / Total power input × 100%
= 1 620,000 W / 1968 000 W × 100
= 0.823 × 100

E = 82.3 %
≈ 82 %

efficiency = ......... 82 .........% [3]

**(c)** Hydroelectric energy is a renewable form of energy.

**(i)** State **one** disadvantage of hydroelectric power schemes.

Construction of dams is expensive ......... [1]

**(ii)** State **one** other renewable source of energy.

wind, geothermal, tidal, wave, biofuel ......... [1]

[Total: 9]

**3** **(a)** Fig. 3.1 shows a boat stored in a shed. The boat is suspended from the ceiling of the shed by two ropes.

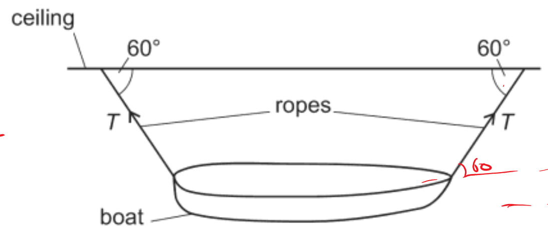
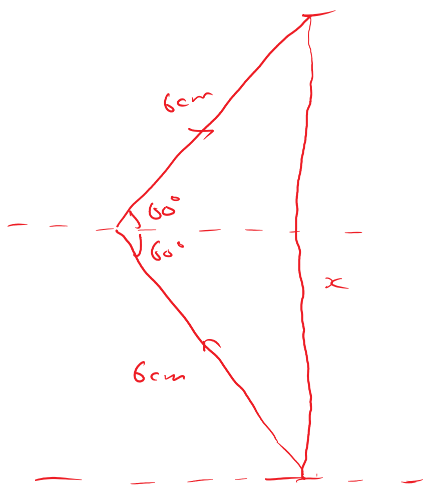



**Fig. 3.1**

The tension $T$ in each of the ropes is 75 N.

**(i)** Draw a vector diagram to determine the resultant of the forces exerted by the two ropes on the boat. State the scale you used.




scale = 2cm : 25N

magnitude of resultant force = 130 N

direction of resultant force = Vertically upwards. [4]

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**(ii)** Determine the mass of the boat.

W = 130 N

W = m × g

$m = \frac{W}{g}$

$= \frac{130\ N}{10} = 13\ kg$

mass = ..............13 kg.............. [1]

**(b)** Force is a vector.

Draw a circle around **two** other quantities in the list which are vectors.

**acceleration** **density** **energy** **mass**

**momentum** **power** **refractive index**

[2]

[Total: 7]

**4** **(a)** Fig. 4.1 shows apparatus used to observe the motion of smoke particles (Brownian motion).

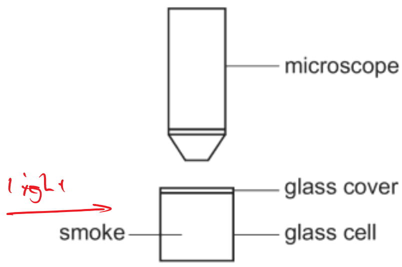
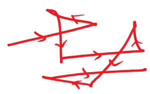



**Fig. 4.1**

The glass cell has light shining on it from the side.

The smoke particles are seen as bright specks of light when looking through the microscope.

**(i)** Draw the path of **one** of the bright specks of light.



[2]

**(ii)** Explain, in terms of forces and the motion of air molecules, the cause of the motion of the smoke particles.

– Smoke particles are bombarded by the air molecules which are moving in random directions
– The air molecules are small and moving fast and exert a force on the large smoke particle during collisions. [4]

**(b)** The temperature of the air in a sealed glass container is increased.

**(i)** Explain, in terms of molecules, why the internal energy of the air increases. ← I.E = K.E + P.E

– K.E of molecules increase when there is temperature increase [1]

**(ii)** Explain, in terms of molecules, why the pressure of the air also increases.

– Change in momentum of air molecule increase as they hit the sides of the container harder and frequently. [2]

[Total: 9]

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**5** **(a)** Define specific heat capacity.

– Energy required to raise the temperature of 1kg of a substance by 1°C ..... [2]

**(b)** A bowl contains 500 cm$^3$ of water at a temperature of 5.0 °C. The bowl of water is placed in a freezer for several hours. When the bowl is removed from the freezer, it contains ice at a temperature of –18.0 °C. The density of water is 1000 kg / m$^3$.

$500\,cm^3 = 500 \times 10^{-6}\,m^3$

**(i)** Calculate the mass of water in the bowl when it is placed in the freezer.

$1000\,kg/m^3 = 1\,g/cm^3$

$\rho = \frac{m}{V}$

$m = \rho \times V$

$= \frac{1g}{cm^3} \times 500\,cm^3$

$= \frac{500g}{1000} = 0.5\,kg$

mass = ..... 0.50 kg ..... [2]

**(ii)** The specific heat capacity of water is 4200 J / (kg °C). The specific heat capacity of ice is 2100 J / (kg °C). The specific latent heat of fusion of water is 3.3 × 10$^5$ J / kg.

Calculate the energy given out as the water cools from 5.0 °C to ice at –18.0 °C.

$E = mc\Delta T$ , $E = mL$

$= 0.5\,kg \times 4200 \frac{J}{kg\,°C} \times (0-5)°C$

$= 0.5 \times 4200 \times 5$

$= 10{,}500\,J$ ✓

$E = mL$

$= 0.5\,kg \times 3.3 \times 10^5 \frac{J}{kg}$

$= 165{,}000\,J$ ✓

$E = mc\Delta T$

$= 0.5\,kg \times 2100 \frac{J}{kg\,°C} \times (18-0)°C$

$= 0.5 \times 2100\,J \times 18$

$= 18{,}900\,J$ ✓

$E = 18900 + 10{,}500 + 165{,}000$

$= 194{,}400\,J$

$= 190{,}000\,J$

energy = ..... 190,000 J ..... [5]

190 kJ

$1.9 \times 10^5\,J$

[Total: 9]

**6** **(a)** **(i)** Fig. 6.1 shows crests of a plane water wave approaching a barrier with a gap.

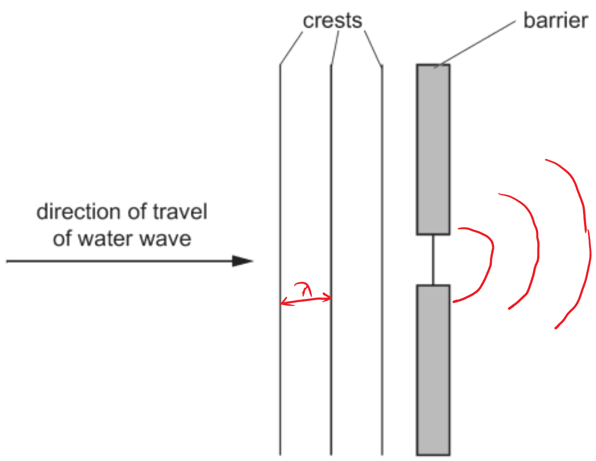


**Fig. 6.1**

On Fig. 6.1, draw **three** crests of the water wave to the right of the barrier. [2]

**(ii)** Fig. 6.2 shows crests of a plane water wave in deep water approaching a region of shallow water.

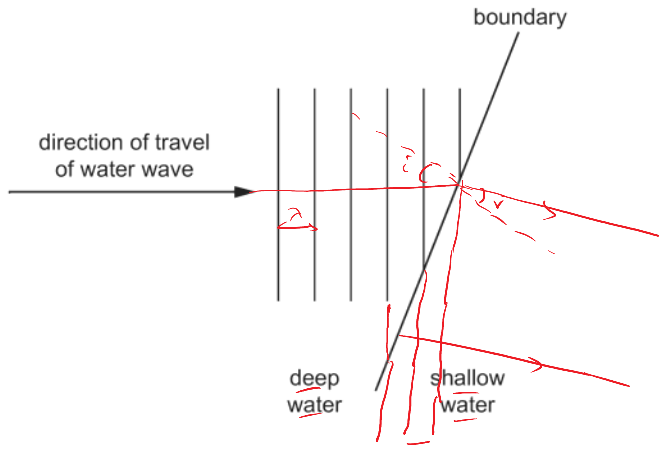


**Fig. 6.2**

The water wave moves more slowly in shallow water.

On Fig. 6.2, draw:

**1.** **three** crests of the water wave in the shallow water [2]

**2.** the direction of travel of the wave in the shallow water. [1]

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**(b)** State **two** ways in which transverse waves differ from longitudinal waves.

1. In tranverse, particles vibration is perpendicular to wave propagation while in longitudinal they vibrate parallel.

2. In tranverse, wave have crest and troughs, while in longitudinal the wave have compression and rarefaction.

[2]

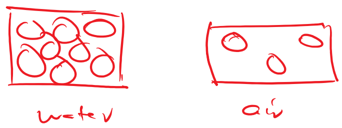
**(c)** **(i)** State a typical value of the speed of sound in water.

1500 m/s [1]

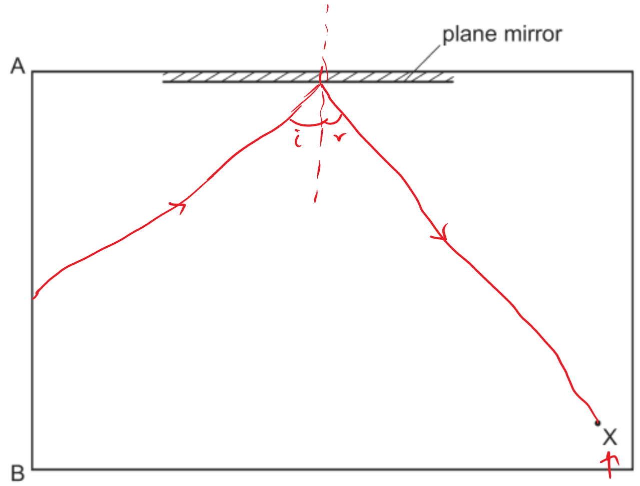
**(ii)** Explain why sound travels faster in water than in air. 330 m/s

Molecules closer together in water [1]

[Total: 9]



7 (a) Fig. 7.1 shows a plan view of a room. There is a plane mirror on one wall and a picture across the whole of wall AB.




i = r

**Fig. 7.1** (plan view)

A person is standing at point X and is looking at the mirror. The person cannot see all of the picture on wall AB reflected in the mirror.

There is a point P on wall AB which is the closest point to A that the person can see reflected in the mirror.

On Fig. 7.1, draw a reflected ray and an incident ray to show the position of the point P. [2]

(b) State **two** properties of the image formed by the mirror.

1. Virtual

2. Upright

3. Same size as object

4. Laterally inverted

[2]

(c) Visible light is an electromagnetic wave.

State the name of **one** region of the electromagnetic spectrum in which the waves have:

(i) shorter wavelengths than visible light

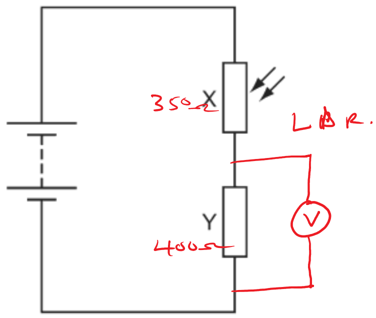
UV, X-ray, gamma-rays [1]

(ii) longer wavelengths than visible light.

IR, microwave, Radio waves [1]

[Total: 6]

**8** **(a)** Fig. 8.1 shows a circuit.




$R_T = 400 + 350$
$= 750\,\Omega$

**Fig. 8.1**

**(i)** State the name of component X.

Light dependent resistor (LDR). ..................................................... [1]

**(ii)** The potential difference (p.d.) across component Y is measured with a voltmeter.

On Fig. 8.1, draw the symbol for the voltmeter and its connections to the circuit. [1]

**(iii)** The electromotive force (e.m.f.) of the battery is 12 V.

Component Y has a resistance of 400 Ω.

In a brightly lit room, the resistance of component X is 350 Ω.

**1.** Calculate the current in the circuit.

$I = \frac{V}{R}$

$= \frac{12V}{750\,\Omega}$

$= 0.016A$

current = ..........0.016 A.......... [2]

**2.** Calculate the p.d. across component Y.

$V = I \times R$

$= 0.016A \times 400\,\Omega$

$= 6.4V$

12.0
− 6.4
5.6 V

p.d. = ..........6.4 V.......... [1]

**(iv)** In a dark room, the resistance of component X is very large.

$V = IR$
$V \propto R$
12.0V

State the effect this will have on the p.d. across component Y.

p.d across Y will decrease. ..................................................... [1]

**(b)** Suggest a practical use for component X.

Used to switch on or off street light ..................................................... [1]

[Total: 7]

**9** **(a)** Fig. 9.1 shows a magnet on the end of a spring and a coil of wire connected to a sensitive centre-zero galvanometer. The magnet can move freely through the coil.

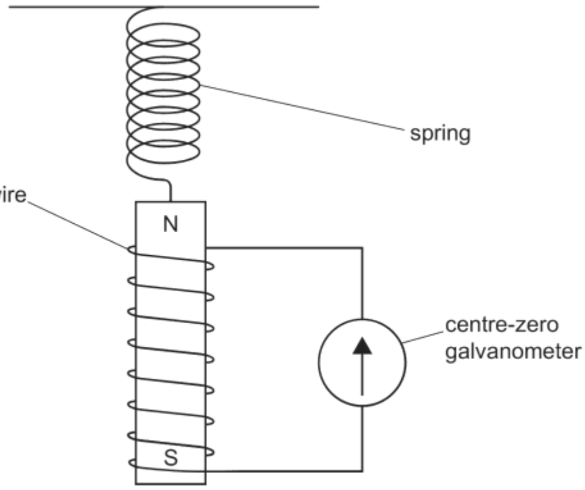



**Fig. 9.1**

**(i)** The magnet is pulled down and released.

Describe and explain what happens to the needle of the sensitive galvanometer.

- The needle oscillates left and right as the magnets moves up and down.
- Magnetic field will cut the coil and induces a voltages, which changes direction [4]

**(ii)** The magnet is replaced with a stronger magnet.

State the effect of using a stronger magnet on what happens to the needle of the galvanometer.

Needle deflection is large [1]

**(b)** A step-up transformer is used to step up the output voltage of a power station from 25 000 V to 400 000 V for transmission along power lines.

The number of turns on the secondary coil is 36 000.

Calculate the number of turns on the primary coil.

$\frac{N_p}{N_s} = \frac{V_p}{V_s}$

$N_p = \frac{V_p \times N_s}{V_s}$

$= \frac{25000 \times 36000}{400000}$

$= 2,250$ turn

$\simeq 2300$ turns

number of turns = ............2300............ [2]

[Total: 7]

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**10** A student places a sample of an isotope of protactinium (Pa-234) near a radiation detector. The readings on the detector, taken every 20 s, are recorded in Table 10.1.

**Table 10.1**

| time / s | count rate counts / min |
|---|---|
| 0 | 101 |
| 20 | 88 |
| 40 | 76 |
| 60 | 66 |
| 80 | 58 |
| 100 | 51 |
| 120 | 46 |
| 140 | 42 |
| 160 | 38 |
| 180 | 35 |

Fig. 10.1 shows a graph of the count rate **due to this sample** against time.

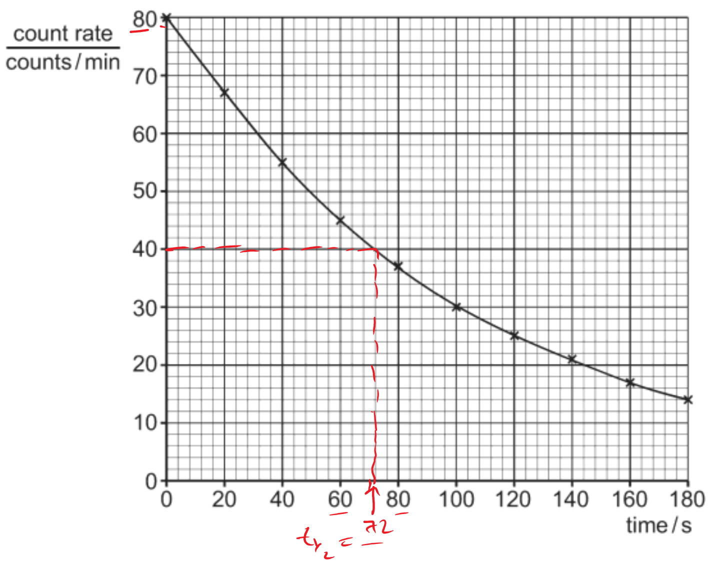


**Fig. 10.1**

**(a)** Explain why the readings in Table 10.1 are **not** the same as those plotted on the graph.

– Background radiation is present in table 10.1

– Plotted data, background radiation is removed. [2]

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**(b)** Using the graph in Fig. 10.1, determine the half-life of this isotope of protactinium.

$\frac{80}{2} = 40$

half-life = ........72 s........ s [2]

**(c)** The nuclide notation for this isotope of protactinium is $^{234}_{91}Pa$.

Protactinium-234 decays to an isotope of uranium (U) by β-emission.

Write down the nuclide equation for this decay of protactinium-234. $^{0}_{-1}e$

$^{236}_{91}Pa \longrightarrow ^{y}_{x}U + ^{0}_{-1}\beta$

$91 = x + -1$
$91 = x - 1$
$x = 92$
$236 = y + 0$
$y = 236$

$^{236}_{91}Pa \longrightarrow ^{236}_{92}U + ^{0}_{-1}\beta$

[3]

[Total: 7]

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