Cambridge Assessment International Education

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6505690795

PHYSICS **0625/42**

Paper 4 Theory (Extended) **May/June 2023**

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 9.8 N (acceleration of free fall = 9.8 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.

DC (CE/CT) 315744/3

1 (a) Fig. 1.1 shows a helicopter which is stationary at a height of 1500 m above the ground.

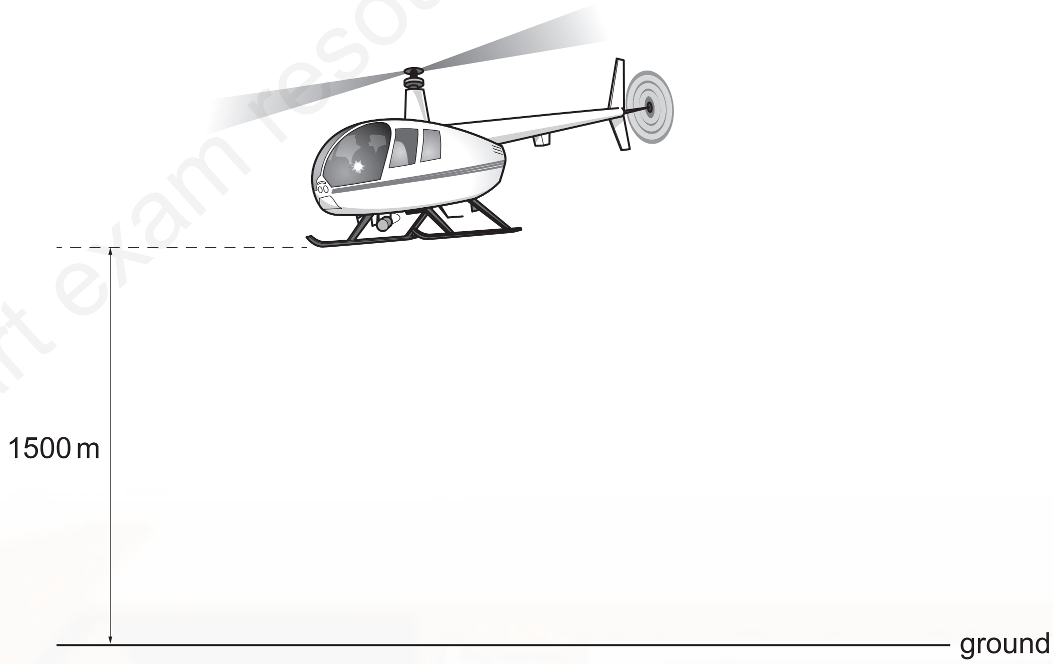

Fig. 1.1 (not to scale)

(i) State the **two** conditions necessary for the helicopter to remain in equilibrium.

condition 1 no resultant force ....

....

condition 2 no resultant moment ....

....
[2]

(ii) The mass of the helicopter is 3200 kg.

Calculate the change in the gravitational potential energy of the helicopter as it rises from the ground to 1500 m.

$(\Delta)E_p = mg(\Delta)h$

$= 3200 \times 9.8 \times 1500$

change in gravitational potential energy = 4.7×10^7 J [2]

(b) Fig. 1.2 shows a vertical speed–time graph for a parachutist who jumps from a stationary hot-air balloon.

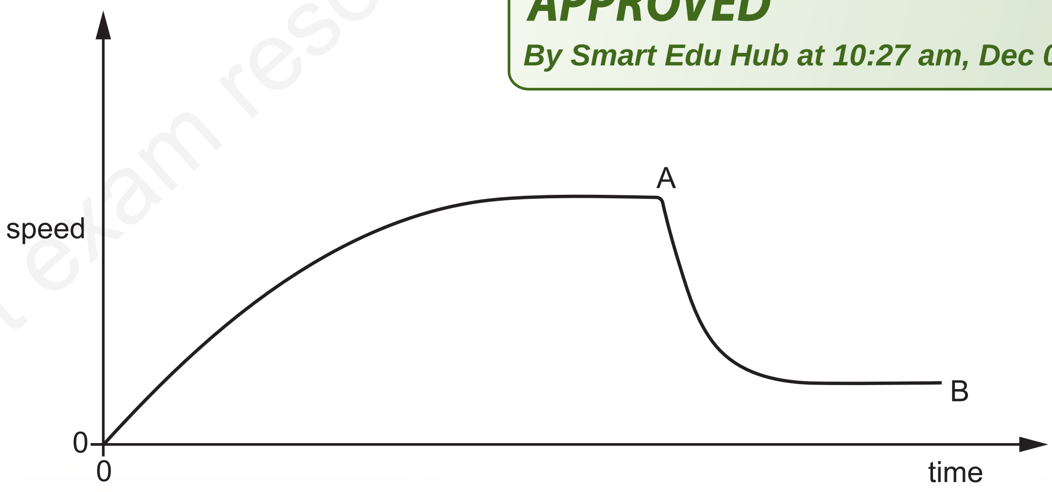

Fig. 1.2

The parachutist jumps from the balloon at time = 0 and reaches the ground at B. The point A indicates when the parachute opens.

(i) On Fig. 1.2, label a point on the graph where the acceleration is:

- zero with '1'
- negative with '2'
- decreasing with '3'. [3]

(ii) Explain, in terms of forces, the changes in motion which occur from when the parachutist leaves the hot-air balloon until point A.

Initially there is acceleration due to weight. Then the air resistance increases as speed or velocity increases .As air resistance increases, resultant force downwards decreases Finally, the parachutist attains a constant speed when air resistance = weight

.... [4]

[Total: 11]

2 A student catches a cricket ball. The speed of the ball immediately before it is caught is 18 m/s. The mass of the cricket ball is 160 g.

(a) Calculate the kinetic energy stored in the cricket ball immediately before it is caught.

$E_K = ½mv^2$
$= 0.5 \times (160/1000) \times (18)^2$
$=26J$

Note: The mass needs to be converted from g to kg by dividing by 100

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kinetic energy = 26J [3]

(b) It takes 0.12 s to catch the ball and bring it to rest.

Calculate the average force exerted on the ball.

$Ft = \Delta mv$
$F= [\Delta mv] / t$
$= [0.16 \times 18] /0.12$
$=24N$

Note: Ft is impulse

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average force = 24N [2]

(c) As the student catches the ball, she moves her hands backwards.

Explain the effect of this action on the student's hands.

This results in longer time of impact and does not hurt as much

.... [1]

[Total: 6]

3 **(a)** Fig. 3.1 shows a person moving across an ice-covered pond to reach a ball on the ice.

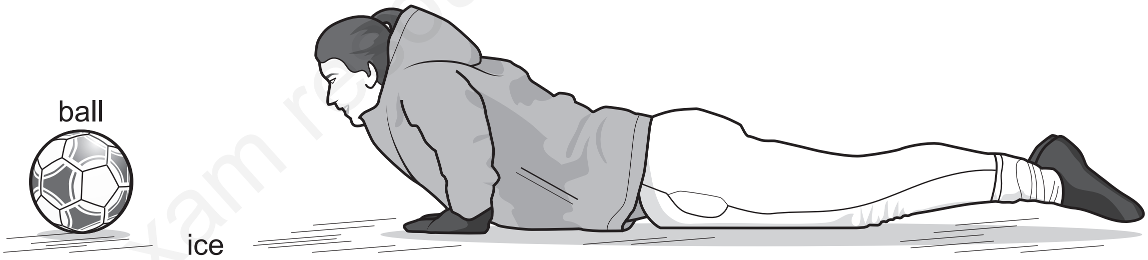

Fig. 3.1

Explain why this way of moving across the ice is safer than walking. Use your understanding of pressure in your answer.

The weight of person is spread over a much greater area . Also, p = F/ A. The force is same so, the pressure is lower and hence the ice is less likely to crack

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[3]

(b) Fig. 3.2 shows a side view of the pond with a layer of ice floating freely on the water.

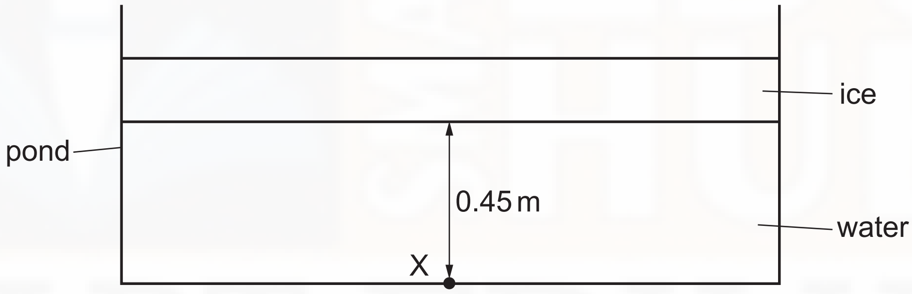

Fig. 3.2

The surface area of the pond is 5.0 m^2.
The mass of the ice is 690 kg.
The density of water is 1000 kg / m^3.
Point X is 0.45 m below the ice.

Calculate the pressure at point X due to the ice and the water.

p (due to water) =ρgh
p =) 1000 x 9.8 x 0.45
p =) 4410

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p (due to ice) =Force / Area
= mg / Area
= [690 x 9.8] / 5= 1352.4

Total pressure = 4410 + 1352.4 = 5.8 x 10^3Pa

pressure = **5.8 x 10^3Pa** [4]

[Total: 7]

4 (a) The temperature of a fixed mass of gas at constant volume is decreased.

State and explain, in terms of particles, how the pressure of the gas changes.

The pressure decreases and the particles have smaller velocity .Therefore, there is lower frequency of collision of particles and hence particles collide with smaller force ....

....

.... [3]

(b) (i) State the value of absolute zero in °C.

value of absolute zero = -273 °C [1]

(ii) Explain what is meant by the term absolute zero. Refer to particles in your answer.

Absolute zero refers to the temperature at which the particles have least kinetic energy .It is the lowest possible temperature

....

.... [2]

(c) Cylinder 1 contains 350 cm^3 of gas at a pressure of 9.0×10^4 Pa. The gas is transferred to cylinder 2 and the pressure increases to 1.6×10^5 Pa. The temperature remains constant.

Calculate the volume of cylinder 2.

pV = constant
$P_1V_1 = P_2V_2$
Hence:
$V_2 = [P_1V_1] / P_2$
$= [9.0 \times 10^4 \times 350] / 1.6 \times 10^5$
$= 200 cm^3$

volume = $200 cm^3$ [3]

[Total: 9]

5 (a) Fig. 5.1 shows an electric heater used to heat a room.

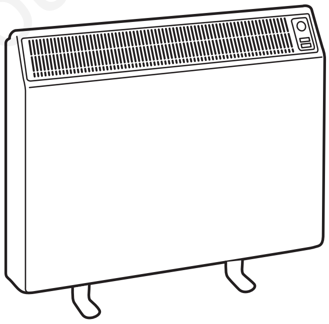


Fig. 5.1

The dimensions of the room are 4.5 m × 6.1 m × 2.4 m.
The density of air is 1.2 kg / m^3.

(i) Show that the mass of air in the room is 79 kg.

Mass= Density x Volume
= 1.2 x 4.5 x 6.1 x 2.4
=79kg

[2]

(ii) The power of the heater is 1100 W. The specific heat capacity of air is 1000 J / (kg °C).

Calculate the time taken to increase the temperature of the air in the room from 16.0 °C to 20.0 °C.

P= (Δ)E / t
t= (Δ)E /P
t= mcΔθ /P
=[79 x 1000 x 4]/1100
=287.27= 290s

time = 290s [4]

(iii) Suggest **one** reason why the time calculated in **(a)(ii)** is the **minimum** time needed to increase the temperature of the air in the room from 16.0 °C to 20.0 °C.

The thermal energy is transferred to the objects in the room

.... [1]

(b) Fig. 5.2 shows a cross-section of a double-glazed window in the room.

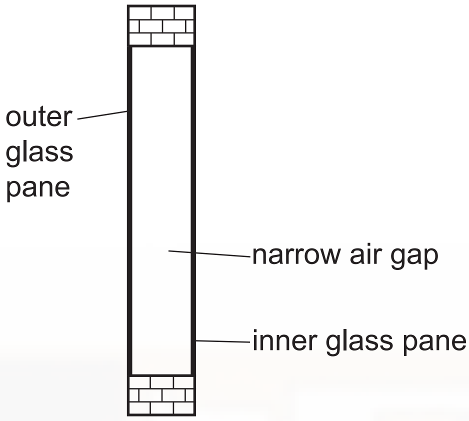


Fig. 5.2

State the main methods of thermal energy transfer from the room to outside which are reduced by this type of window.

Conduction and convection [1]

[Total: 8]

6 Two types of seismic waves are P-waves and S-waves.

(a) State the types of wave that P-waves and S-waves can be modelled as.

P-waves longitudinal

S-waves transverse

[2]

(b) The velocity of a P-wave in the Earth's solid crust is 7.2 km/s and its frequency is 4.5 Hz.

Calculate the wavelength of this P-wave.

$\lambda = v/f$

$= [7.2 \times 1000] / 4.5$

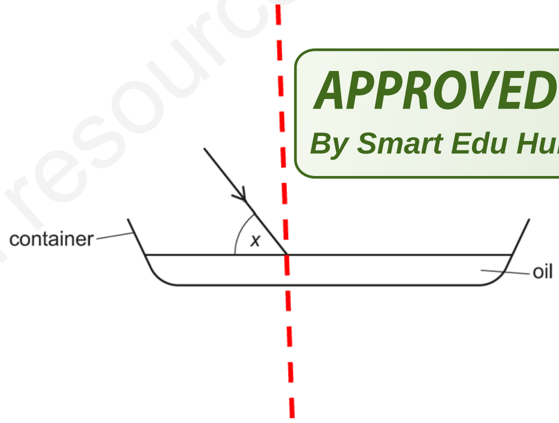
$= 1600\text{m}$

Convert 7.2 km to m by multiplying by 1000

wavelength = 1600m [3]

[Total: 5]

7 Fig. 7.1 shows a container of oil.



A ray of light shines on the surface of the oil. The refractive index of the oil is 1.47.

(a) On Fig. 7.1, draw the normal at the point where the ray enters the oil. [1]

(b) The angle *x* is 56°.

Calculate the value of the angle of refraction.

Refractive index (n)= Sin (i) / Sin (r)
Sin(r)= Sin(i)/ n= Sin 34 / 1.56
Sinr =0.38
r= Sin^{-1}(0.38) = 22^0

Note: i= 90-56=34
[Angle between normal and incident ray

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angle of refraction = **22^0** [3]

(c) State the approximate speed of light in air.

3.0×10^8 m /s [1]

(d) Calculate the speed of light in the oil.

Give your answer to three significant figures.

Refractive index (n) = (Speed of light in air) / Speed of light in oil)
= 3.0×10^8 / 1.47
= 2.04×10^8 m/s

.04 x 10^8 m/s

speed = ... [2]

[Total: 7]

8 **(a)** **(i)** State what is meant by a magnetic field.

Magnetic field is the region in which a magnetic pole experiences a force

.... [1]

(ii) Define the direction of a magnetic field.

It is in the direction of the force on the N pole

.... [1]

(b) Fig. 8.1 shows a negatively charged metal sphere.

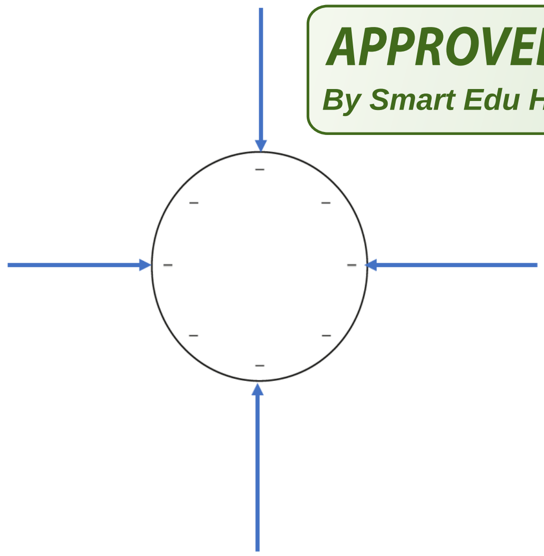

Fig. 8.1

On Fig. 8.1, draw **four** lines to show the electric field and its direction. [2]

(c) Fig. 8.2 shows a circuit.

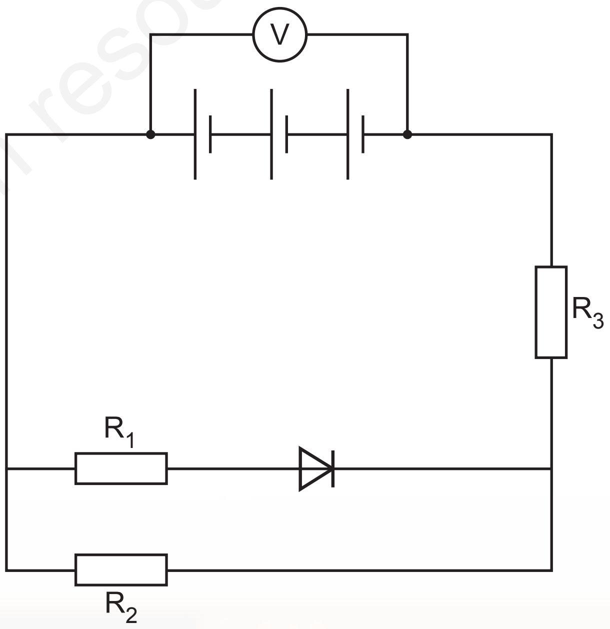

Fig. 8.2

The three cells are identical and have zero resistance.
The resistors R_1, R_2 and R_3 are identical.
The reading on the voltmeter is 6.0 V.
When the diode is conducting, it has zero resistance and zero potential difference (p.d.) across it.

(i) Determine the e.m.f. of one cell.

Note: 6/3=2

e.m.f. = 2.0V [1]

(ii) Determine the ratio of the p.d. across R_2 to the p.d. across R_3.

Note: The Resistors R1 and R2 are parallel to each other. But their combination is in series with R3

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R2 :R3 = 1 : 2 [1]

(iii) All the cells are reversed.

1. State and explain the change in current in R_1.

The current is zero in R1 and the diode is in wrong direction to allow current

[1]

2. Determine the new value of the ratio of the p.d. across R_2 to the p.d. across R_3.

Ratio of p.d. across
R2 : R3
= 1 : 1 [1]

[Total: 8]

9 **(a)** Table 9.1 shows some properties and values for α-particles, β-particles and γ-radiation.

Complete Table 9.1.

Table 9.1

type of radiation	number of protons	number of neutrons	charge / C	stopped by
α	2	2	$+3.2 \times 10^{-19}$	thin sheet of paper
β	0	0	-1.6 x 10-19	thin sheet of aluminium
γ	0	0	0	very thick concrete

[3]

(b) State how β-decay changes the nucleus of an atom.

The nucleus has one less neutron and one more proton .... [1]

(c) A radiation detector used in a laboratory detects a background count rate of 30 counts / min. A radioactive source is placed in front of the radiation detector. The initial reading on the detector is 550 counts / min. The half-life of the source is 25 minutes.

Calculate the expected reading on the detector after 75 minutes.

Initial count rate due to source = 550 – 30 (counts / min) = 520 (counts / min)
One Half Life =25 mins. 3 Half Lives =75 minutes.
Final count rate due to source = (520 / 8 =) 65
Expected Reading on the detector= 65 + 30= 95 (counts / min)

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reading = ... 95 .... counts / min [4]

(d) State **two** safety precautions taken when moving, using or storing radioactive sources in a laboratory.

1 limit the time of exposure ....

2 store sources in lead boxes ....

[2]

[Total: 10]

10 **(a)** State the equation that defines the average orbital speed *v* of a planet. State the meaning of any symbols you use.

$v = 2\pi r/T$

r = average radius of the orbit and T = orbital period

[2]

(b) Suggest why countries that are a significant distance from the Equator experience significant temperature variation throughout the year.

The rays from Sun strike the country at different angles through the year

[1]

(c) Fill in the gaps in the paragraph about a star much more massive than the Sun.

The stage that follows the stable state in the life cycle of the star is the

red supergiant stage.

It then explodes as a supernova to form a nebula, this leaves behind a

neutron star or a black hole.

[4]

(d) A galaxy is moving away from the Earth with a speed of 33 000 km/s.
The value of the Hubble constant is 2.2×10^{-18} per second.

Calculate the distance from the galaxy to the Earth. Give your answer in light-years.

$H_0 = v/d$

Hence:

$d = v / H_0$

$d = [33\,000 \times 10^3] / [2.2 \times 10^{-18} \times 9.5 \times 10^{15}]$

Note:

- 33000km/s m/s by multiplying by 1000
- One light year= 9.5×10^{15}m

distance = 1.6×10^9 light-years [2]

[Total: 9]

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