

Science (Physics) – Set III

2024 4E SciPhy Prelim Answers

Paper 1: 20 marks

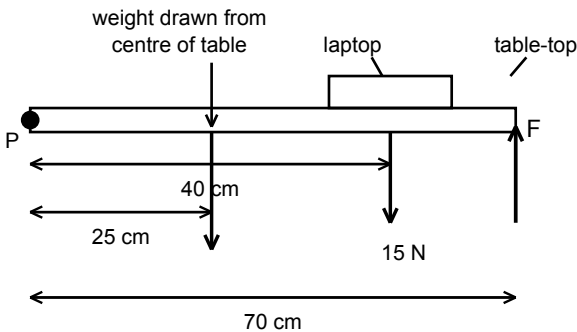
Not the school's key. The grid printed with this scheme is the key to a different paper – its letters are the answers to Set IV's multiple-choice paper, and they do not fit the questions in this one (its Q1 is marked A, but 0.1 nm in SI units is 1×10^{-10} m, which is D). The answers below were worked out from the questions instead, and the reasoning for each is given underneath. Check them before use.

1	2	3	4	5
D	C	B	C	A
6	7	8	9	10
C	C	D	D	C
11	12	13	14	15
B	D	D	B	C
16	17	18	19	20
A	A	C	B	A

How each Paper 1 answer was reached

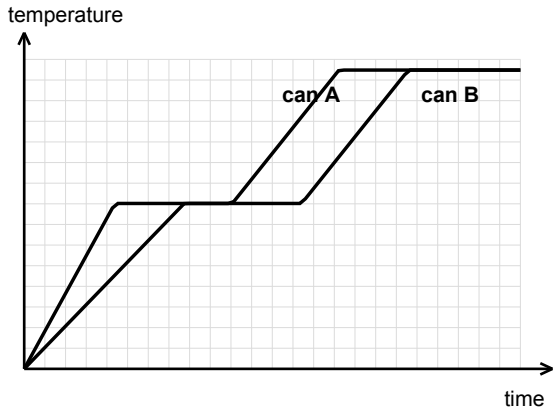
1	D	0.1 nm = 1×10^{-10} m; the SI unit of length is the metre.
2	C	The hand starts at 0 and ends 279° round a 60 s dial: $279/6 = 46.5$ s.
3	B	The distance–time curve flattens, so the gradient – the speed – is falling.
4	C	Density is mass per unit volume; he divided by weight.
5	A	Constant speed on a smooth level track means zero resultant force.
6	C	C sits furthest from the hinges, so it gives the largest moment for a given force.
7	C	The crest is $30 + 10 = 40$ cm above X: $v = \sqrt{2 \times 10 \times 0.40} = 2.8$ m/s.
8	D	Heating at constant volume raises the mean speed of the molecules.
9	D	Wool traps air, a poor conductor; the other three work by radiation or convection.
10	C	Each crest is a wavefront. X is one wavelength, Y is two, and the frequency is $3/2 = 1.5$ Hz.
11	B	Same amplitude, three cycles against four, so a lower frequency and a lower pitch.
12	D	X-rays penetrate metal and reveal flaws in a weld.
13	D	The image lies as far behind the mirror as the object is in front, on the normal through the object.
14	B	The ray that arrives parallel to the axis crosses it at the 10 cm mark, which is the focal point.
15	C	P and Q swing apart, so Q is positive like P; Q and R swing together, so R is negative.
16	A	A carries the whole circuit current; the other four each carry a share of it.
17	A	The neutral wire sits at earth potential, near 0 V. $1800/8 = 225$ V is the supply voltage, not the neutral's.
18	C	Only repulsion proves magnetism: Q repels U, so rods 1 and 3 are the magnets.
19	B	By the right-hand grip rule a current into the page gives a clockwise field.
20	A	20 hours is four half-lives: $0.48/2^4 = 0.03$ g.

Paper 2 – Section A

1	(a)	The driver needs time to react / the driver has reaction time. [Some students wrote that it is due to inertia/car was already travelling at constant speed]	[1]
	(b)	Distance = Area under the graph = $\frac{1}{2} \times 27 \times (0.6 + 2.8)$ = 46 m The car will not collide with the obstacle because the distance travelled is less than 50 m. accept ecf	[1] [1]
	(c)	$a = (v - u) / t$ $a = (0 - 27) / (2.8 - 0.6)$ $a = -12 \text{ m/s}^2$ $d = 12 \text{ m/s}^2$	[1] [1]
	(d)	$F = ma$ $F = 1600 \times 12$ $F = 19\,200 \text{ N}$ [answers cannot be more than 3 s.f.]	[1] [1]
2	(a)	$W = mg$ $W = 80 \times 10 = 800 \text{ N}$	[1]
	(b)	air resistance	[1]
	(c)	The air resistance is equal in magnitude to the weight [1]. Resultant force is zero [1]. [poorly answered. Students need to be specific that the two mentioned forces are equal]	[1] [1]
3	(a)		[1]
	(b)(i)	$cw = (60 \times 0.25) + (15 \times 0.4)$ [1] $cw = 21 \text{ Nm}$ [1] accept ecf [distance must be converted to metre]	[1] [1]
	(ii)	$acw = cw$ $F \times 0.70 = 21$ $F = 30 \text{ N}$ accept ecf	[1] [1]
	(c)	F will decrease. The clockwise moment caused by the laptop decreases. [clockwise moment decreases is missing from some students]	[1]
4	(a)	Refractive index of water = $c/v = 3.0 \times 10^8 / 2.3 \times 10^8 = 1.30$ Refractive index of water = $1.30 = \sin i / \sin r = \sin r / \sin 30$ $r = 41^\circ$	[1] [1] [1]

	(b)	Light will bend towards the normal as light will slow down as it enters glass / travel from optically denser medium to less dense medium.	[1] [1]
5	(a)	6.1 cm (+/- 0.1 cm)	
	(b)	$v = f \lambda = 5.1 \times 10^3 \times 0.061$ = 311 m/s (3 s.f.)	[1] [1]
	(c)(i)	Sound waves are longitudinal waves but electromagnetic waves are transverse waves. Sound waves require a medium to travel while electromagnetic waves can travel through vacuum.	[1] [1]
	(c)(ii)	visible light infra-red radiation	[1] [1]
6	(a)	– wire A is connected to the switch. When switch is open, the wire will be no longer be at high voltage, making it safe. – If wire B is the live wire, it will always remain at high voltage even though the lamp is switched off. (answer should include why B is not suitable) [poorly answered. Many just name the two wires]	[1] [1]
	(b)(i)	current = power / voltage = 100 / 230 = 0.435 A [many state the wrong formula and use 230/100]	[1] [1]
	(ii)	The lamp will be at the same brightness. The potential difference across both lamps are the same, thus the current flowing through each lamp is the same as before and the brightness is the same. [some just explain that it is a parallel circuit or that current through both is the same without referencing to the previous arrangement]	[1] [1]
7	(a)	North-pole N of the compass points to the left. Coil C becomes an electromagnet and its right end becomes a South pole, the compass North-pole will turn to the left since unlike poles attracts. [state that one side of the electromagnet is a south pole]	[1] [1]
	(b)(i)	North-pole N of the compass points back to the right, very quickly/immediately (soft iron loses magnetism quickly)	[1]
	(b)(ii)	North-pole N of the compass will remain	[1]
	(c)	North-pole N of the compass vibrates about its pivoted centre. [poorly answered. Many do not understand nature of a.c.]	[1]
8	(a)	Isotope A has a short penetration distance and a longer half-life than isotope D (no marks if a wrong isotope is mentioned or correct isotope with wrong explanation)	[1] [1]
	(b)	It can be used for cancer treatment. It causes mutation of cells. Any plausible answers	[1] [1]
9	(a)	$m = V \times \rho$ $m = 1.5 \times 1000$ $m = 1500 \text{ kg}$	[1] [1]

	(b)	GPE loss = mgh GPE loss = $1500 \times 10 \times 120$ GPE loss = 1 800 000 J Accept ecf	[1] [1]
	(c)	KE gain = GPE loss $1\,800\,000 = \frac{1}{2} \times 1500 \times v^2$ $v = 49 \text{ m/s}$ accept ecf	[1] [1]
	(d)	Some of the gravitational potential energy has been converted to heat and sound energy as the water flows down.	[1]
	(e)	$P = F/A$ $F = PA$ $F = 8000 \times 4$ $F = 32\,000 \text{ N}$	[1] [1]
	(f)	Increase the height of the reservoir from the turbine or Increase the contact area of the blade / have more blades [some misunderstand that by decreasing contact area, pressure will increase]	[1]
10	(a)	$P = VI$ $0.88 \times 1000 = 220 \times I$ $I = 4.0 \text{ A}$	[1] [1]
	(b)	$V = RI$ $220 = R \times 4.0$ $R = 55 \, \Omega$	[1] [1]
	(c)	$1/R = 1/55 + 1/55 + 1/55 + 1/55$ $R = 14 \, \Omega$ OR $V = RI$ $220 = R \times (4 \times 4.0)$ $R = 14 \, \Omega$	[1] [1]
	(d)	The total current used by the system is 16 A. the fuse cannot be used because its <u>rating must be more than 16 A.</u>	[1]
	(e)(i)	$R = 4 \times 55 = 220 \, \Omega$ $V = RI$ $220 = 220 \times I$ $I = 1.0 \text{ A}$	[1] [1]
	(ii)	The current through each fan is only 1.0 A when a current of 4.0 A is required to operate it normally. The current through the fan is smaller than the required current. The potential difference across each fan is less than the required potential difference of 220 V. Either one [will not accept fan is slower without relevant explanation, not about overheating as well]	[1]

11	(a)	The particles near the heater gain energy and vibrate faster. They collide with neighbouring particles which in turn collide with other particles around them. Energy is thus transferred from one particle to another by conduction. [question focus on transfer of energy through the walls, not about radiation]	[1] [1]
	(b)	Air is a poor conductor of thermal energy	[1]
	(c)(i)	 – steeper lines [1] – horizontal line starts earlier but at same temp [1] [many drew the horizontal line at a higher temp]	[2]
	(ii)	Because can A is a good absorber of radiation [many stated the difference rather than explaining the difference. Students need to know what explaining means]	[1]
	(d)	Before the melting point, molecules of wax are packed closely together in a regular arrangement and vibrate about their fixed position. As temperature increases, they vibrate more vigorously about their fixed position. During melting, the molecules break away from the regular arrangement. After the melting point, the molecules are slightly further apart from each other and do not have a regular arrangement. They are able to slide around each other.	[1] [1] [1] [1]