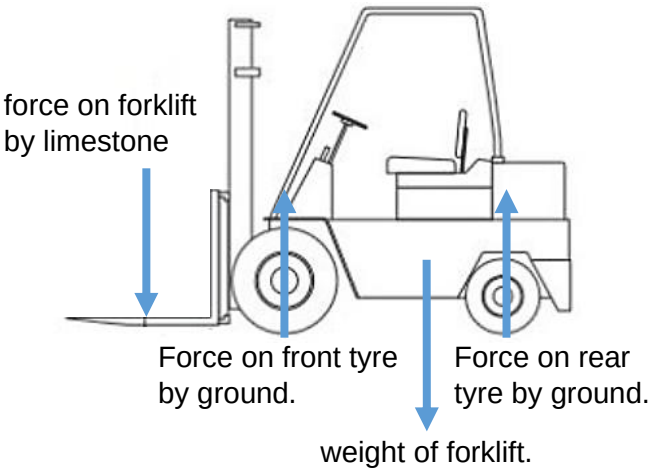
Physics Prelim 2022 Answers

1	2	3	4	5	6	7	8	9	10
B	D	B	C	C	C	A	B	C	B
11	12	13	14	15	16	17	18	19	20
D	D	C	D	D	A	A	C	A	B
21	22	23	24	25	26	27	28	29	30
D	B	D	D	A	A	D	D	C	D
31	32	33	34	35	36	37	38	39	40
B	A	C	A	C	A	A	D	B	C

		Suggested Solution
1	**(a)(i)**	Density is defined as mass per unit volume.
	(a)(ii)	Mass of a 1 m^3 cube of limestone = density x volume = 2.71 x $(50)^3$ g = 340 kg (correct to 2 s.f.) (shown)
	(b)(i)	
	(b)(ii)	Take y to be the number of identical limestone blocks that can be lifted. Taking moments about the front wheel, Sum of clockwise moments = Sum of anti-clockwise moments (1000) x (1.0) x (10) = (340) x (0.9) x (10) x (y) y = 3.27 blocks Therefore the maximum number of blocks is 3.

		Suggested Solution
2	**(a)**	Increase in gravitational potential energy of ball = $mg\Delta h$ = (0.60)(10)(5) = 30 J
	(b)	Kinetic energy at A = Potential energy at B + Kinetic energy at B = 30 J + 8.5 J = 38.5 J

	(c)	The student is incorrect as weight is the only force acting on the basketball after it leaves the student's hand. And weight is the resultant force that causes the (downwards) acceleration of the basketball rather than an upwards acceleration that explains the motion of the ball upwards.
		Suggested Solution
3	**(a)**	Pressure at X = (0.76)(13600)(10) = 1.03 x 10^5 Pa
	(b)(i)	Pressure of trapped gas= Atmospheric Pressure + Pressure due to 10 cm Hg = 76 cm Hg + 10 cm Hg = (86 x 10^{-2})(13 600)(10) = 1.17 x 10^3 Pa
	(ii)	Both levels are correctly drawn at 55 cm
	(c)	The pressure at Y is still 76 cm Hg as the additional pressure is due to the reaction force acting downward on mercury column by barometer.

		Suggested Solution
4	**(a)**	The water particles are in constant random motion and slide over one another.
	(b)	1. As the liquid is heated, its temperature increases that cause the average speed of the particles to increase. 2. This leads to a higher force per collision and higher rate of collision with the walls of the container. Force exerted per unit area increases causing a rise in pressure.
	(c)	Number of divisions between ice point and steam point = 10 divisions Number of divisions from ice point = 6 divisions Temperature of unknown liquid = $\frac{6}{10} \times 100$ °C = 60 °C Or any other relevant mathematical calculations

		Suggested solution
5	**(a)**	It means there is 2 complete rotations/waves produced per second.
	(b)	f = 2 × 8 = 16 Hz v = f λ 330 = 16 × λ λ = 20.6 m
	(c)	New waveform has half the original amplitude (0.5 d). It will have a period that is doubled. So will show 1.75 waves.

		Suggested solution
6	**(a)**	Electric field is a region in which an electric charge experiences an electrostatic force.
	(b)	**(i)** the beam of uncharged particles deflects upwards and is attracted to the positively charged plate. **(ii)** the beam of electromagnetic wave continues undeflected in a straight line.
	(c)	There is electrostatic induction and the electrons in the uncharged particles are attracted to the side closer to the positively charged plate. Since the negative side is closer to the plate than the positive side of the uncharged particles, the particles are attracted to the plate. The gamma wave is uncharged and will not be attracted to the plate hence it continues moving along a straight line.

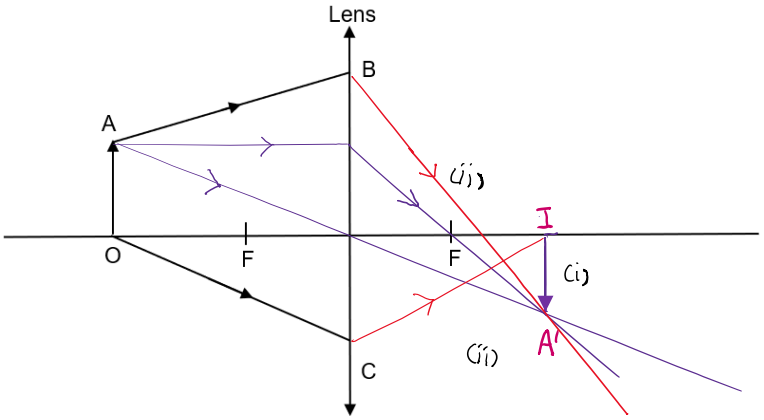
		Suggested solution
7	**(a)**	Voltmeter is connected in parallel to the fixed resistor P.
	(b) **(i)**	$R_p = \frac{V}{I} = \frac{1.2\ V}{0.12\ A}$ = 10 Ω
	(b) **(ii)**	$R = \frac{\rho L}{A}$ $\rho = \frac{AR}{L} = \frac{(6.0 \times 10^{-3} \times 10^{-4}) \times (10)}{4.0 \times 10^{-2}}$ $= 1.5 \times 10^{-4}$ Ωm
	(c)	The ammeter reading increases. When the fixed resistor Q is connected in parallel with fixed resistor P, the effective resistance of the circuit decreases.

		Suggested solution
8	**(a)** **(i)**	2 V across 0.9 MΩ 4 V across the voltmeter will be twice the resistance according to potential divider principle, total resistance across points X and Y = 0.9 × 2 = 1.8 MΩ
	(a) **(ii)**	Resistance across the thermistor, R $\frac{1}{1.8} = \frac{1}{R} + \frac{1}{5.2}$ R = 2.75 MΩ From Fig. 8.1, the temperature of the thermistor = 22.0 °C
	(b)	Disadvantage of using the thermistor is its resistance does not vary linearly with temperature.

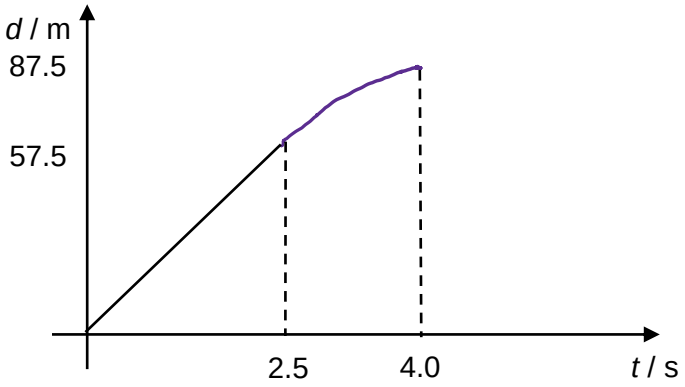
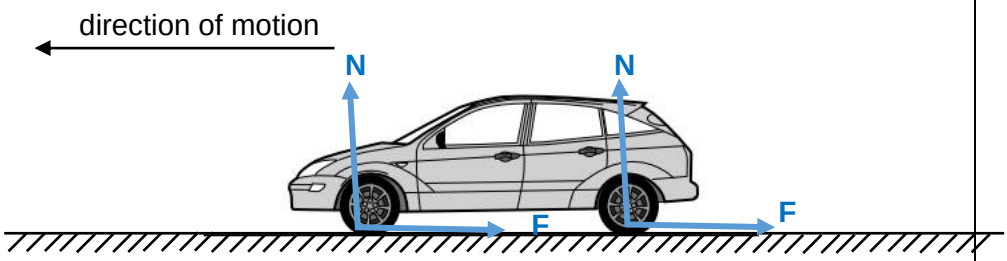
		Suggested solution
9	**(a)**	P = $\frac{V^2}{R}$ $R = \frac{230^2}{50}$ = 1060 Ω (3 s.f.)
	(b)	Energy used in a year = 0.050 kW × 3.6 h × 365 = 65.7 kWh Cost in a year = 65.7 × 0.29 × 3 = $57.16

		Suggested solution
10	**(a)**	1. The direction of the magnetic field in M and N are opposite. 2. The strength of the magnetic field in M and N are different. Magnetic field strength of M is stronger than N.
	(b) (i)	The solenoid is an electromagnet that induces magnetism in the paper clip. The opposite pole of the paper clip is attracted to the magnetic pole of the solenoid.
	(b) (ii)	Since the solenoid is made of steel wire, it retains its magnetism after the switch is opened. So it remains attracted to the solenoid.

		Suggested solution
11	**(a)**	Hot water particles at higher temperature have higher kinetic energy . It collides with the powder and transfers some of its kinetic energy. The average kinetic energy of powder increases, its temperature rises as it gains heat.
	(b) (i)	Heat transfer away by convection as the air above the hot drink heats up by conduction, it expands and rises due to lower density. Cooler air of higher density would move in to be heated and the process repeats.
	(b) (ii)	Cover the cup. This minimizes heat loss by convection of air as the warm air is trapped within the cup.
	(c) (i)	Specific latent heat of fusion of ice is the amount of thermal energy required to change unit mass of ice from solid state to liquid state, without a change of temperature.
	(c) (ii)	Given the assumption of no other heat loss, Heat loss by milo = Heat gain by ice melting + Heat gain by melted ice $(0.4)(4200)(90-\Theta) = (0.05)(3.36 \times 10^5) + (0.05)(4200)(\Theta-0)$ $\Theta = 71.1\ ^{O}C$

		Suggested solution
12	**(a)(i)**	Visible light has a lower frequency than ultraviolet rays.
	(a)(ii)	Lead to premature aging of skin tissues and even skin cancer.
	(b)(i)	V = wavelength / period = 2.0 / 0.02 = 100 m s^{-1}
	(b)(ii)	Correct wave drawn. (shifted by half a wavelength to the right)
	(b)(iii)	The speed will remain constant.
	(c)(i) **(ii)**	 (i) Correct construction of 2 rays to locate image of point A Correct drawing of image IA'. (ii) Both rays from AB and OC must converge on A'. Note: Minus 1m if no arrow head drawn for rays.
	(iii)	Image becomes smaller and nearer to the lens.

		Suggested Solution
13	**(a)**	It means covering equal distance in equal interval of time.
	(b)(i)	Distance travelled = Area bounded by graph and the time axis = $\frac{1}{2}$(17+23)(4.0-2.5) = 30.0 m (2 or 3 s.f. accepted)
	(ii)	Acceleration of car = gradient of velocity-time graph = $\frac{23-17}{4.0-2.5}$ = 4.00 m s^{-2} Resultant force = ma = (1500)(4.00) = 6.00 kN (2 or 3 s.f. accepted)

	(c)	 Correct graph shape. Correct values for both key positions
	(d)	 **Fig. 13.3**
	(e)	As the car turns, **<u>its direction is constantly changing</u>**. Velocity is thus changing. Since **<u>acceleration is defined as the rate of change of velocity, the car experiences acceleration</u>** during the turn at constant speed.

Or

13		Suggested solution
	(a) (i)	Core becomes magnetized due to the current flowing in the coil. Iron armature is attracted to the core and rotates about the pivot. Iron armature pushes the springy metal upwards and closes the contact for current to flow through the motor.
	(a) (ii)	A lower current flows through the switch when it is connected to the relay hence safer as it is connected to a low voltage.
	(b) (i)	It increases the strength of the magnetic field passing through the secondary coil.
	(b) (ii)	The magnetic field of the power source produces an alternating magnetic field that cuts the secondary coil. This results in a changing magnetic flux linkage through the secondary coil. According to Faraday's law of electromagnetic induction, the induced electromotive force produced at the secondary coil is directly proportional to the rate of change of magnetic flux linkage across it causing an output voltage to be produced across the secondary coil.
	(b) (iii)	Using $\frac{V_S}{V_P} = \frac{N_S}{N_P}$, $\frac{20\ V}{230\ V} = \frac{N_S}{1950\ turns}$ N_s = 170 turns