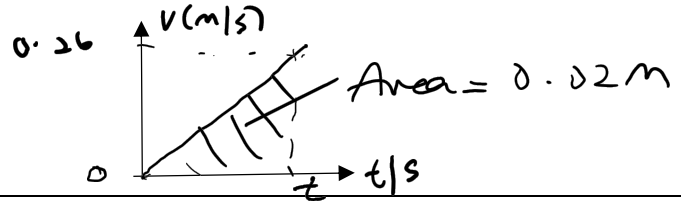
Solutions for 6091(Revised) Paper 2

2024 Preliminary examination Pure Physics Paper 2

Question	Solution	Mark allocation
1(a)	Scale 1cm: 2N (Do not accept '=') Resultant force Accept between 31.5 N to 36.8 N Direction: The resultant force makes an angle of 59° with the horizontal (Accept between 58° to 60°) Diagram: Directions indicated. • Single arrow for 30 N and 18 N force • double arrow for resultant force • Angle indicated. • Forces indicated(not length) Do not accept the following: Directions (north east) Odd scales used for scale Eg 1: 3N; 1 cm : 6N There were students who reversed the scale order Eg 2N : 1cm and this is also unacceptable.	[1] [1] [1] [1] [1]
1(b)	Resultant force has increased Weight has decreased as the gravitational field strength on moon is weaker than the earth Many students missed out on mentioning that the gravitational field strength is weaker on the moon compared to the earth. They had merely mentioned that there is a difference in gravitational field strength and this is not to be accepted.	[1] [1]

1(c)	Increase surface area of balloon or Increase density of air/temperature of air (any one factor) Do not Accept: Increase the mass of the balloon. Students need to understand that most of the makeup of the balloon is air, which is light. The actual mass of the material of the balloon is very light and not feasible to increase this. Any slight increase in mass will only cause negligible change in the resistive force . Hence this factor will not be accepted.	[1]
2(a)(i)	Total clockwise moments 0.150 x 18 + 30 x 0.460 =2.7 + 13.8 =16.5 Nm Many students had only calculated one clockwise moment and hence lost this mark. There are also students who still exhibited weak understanding of the perpendicular distance from the acting force to the pivot and substituted the wrong value for the perpendicular distance in their calculations. Note: No half mark for the calculation of just one clockwise moment. Students will also lose credit if they fail to state the formula before the substitution of values.	[1]
2(a)(ii)	Applying the principal of moments about the pivot, Sum of anticlockwise moments = Sum of clockwise moments F x 0.04 = 16.5 F =412.5 N A sizable number of students did not write the statements in blue and hence lost credit for the failure to mention.	[1]
2(b)(i)	There is no change to the anticlockwise moment as the total clockwise moments has not changed Not well done. There are students who tried applying the law of conservation of energy to this question on moments and failed to explain accurately.	[1] [1]

2(b)(ii)	The perpendicular distance between F and pivot has decreased *hence F has increased.* This part was poorly attempted. Not many students realised that the perpendicular distance has reduced. Many still saw that there was no change to the perpendicular distance.	[1] [1]
3(a)	(i) Increasing acceleration (do not accept acceleration only) (ii) constant deceleration (do not accept deceleration only) There are students who made contradictory statements and were not awarded credit Eg: The velocity is increasing at increasing rate, hence it experiences constant acceleration Eg the velocity is decreasing at a constant rate, hence it experiences zero deceleration. Misconception: acceleration in negative direction	[1] [1]
3(b)	The ***area under the graph*** from t = 0 s to t= 2 s is ***smaller*** than t= 2 s to t = 7s.	
3(c)(i)	Note: Axis label must be written with units, else credit will not be given. There are also students who drew a curve instead of a straight line.  	[1]
3(c)(ii)	Area = 0.02 = 0.5 x t x 0.26 t= 0.154 s This part is badly attempted. Students started solving by considering the gradient instead of the area.	[1]
3(c)(iii)	a = v-u/t = (0.26-0) /0.154 = 1.69 m/s^2 Do note that mark will be deducted it formula and/or units are not given in the final answer	[1]

4(a)	Work done = mgh = 250 x 10 x 15 = 37500 J There are many students who calculated the total energy at A and did not read the question carefully.	[1]
4(b)	E(A) = E(B) Loss in GPE = gain in KE + WD (Friction) 37500 = 0.5 x 250 x ($13^2 - 2^2$) + WD (friction) WD(friction) = 37500 – 20625 = 16875 J This part is badly attempted as students forgot to take into consideration that there is also kinetic store at point A and hence was not able to get any credit for this part.	 [1] [1]
4(c)	Any one The final speed at B will be lower (1). The total change in the energy in the gravitational store of the roller coaster is the same. Deepening the dip will lead to the frictional forces acting over a longer distance. Thus, more energy is transferred to the internal store of the surroundings due to friction and the final speed is lower (1). Or The speed of the roller coaster at the bottom of the dip will be greater (1). There is a greater loss of energy in the gravitational potential store of the roller coaster from the start of the ride to the bottom of the dip. [1] Do not accept: The speed will change. This is a vague statement as there is no mention whether there will be an increase or decrease in the value of the speed.	[2]
4(d)	Energy cannot be created nor destroyed. It can only be converted from one form to another. The total energy in the system remains constant Many students missed out on the statement in blue and lost half a mark There are still students who used 'converted from one type to another' instead of 'form '	 [1]
5(a)	For longitudinal waves, the direction of wave travel is parallel to the direction of the vibration of the particles. Sound wave There are many students who were confused between transverse and longitudinal wave and cited wrong examples eg electromagnetic waves instead. Do not accept: longitudinal waves has compressions and rarefactions.	[1] [1]

5(b)(i)	Displacement = 3 x 0.1 m = 0.3 m There are only a handful of students who managed to get this right	[1]
5(b)(ii)	Speed = distance/ time =0.3/(0.882 x 10^{-3}) =340 m/s Many students did not take into account the prefix for the time(milli) and hence obtained wrong answers for this part. There are also some students who were confused between milli and centi.	
6(a)	More stable than compared to the whole cube Many students did not realise that the new structure of the cube shows a lighter top with a heavier bottom and hence stability has been increased.	[1]
6(b)	Position of CG is lowered.	[1]
7(a)	Pressure(Q) =Pressure(P) P(atm) + (0.2) (1000)(10) =P(atm) + x(800)(10) X = 0.250 m This part is well done. Almost all the students managed to gain credit for this part.	 [1] [1]
7(b)	No difference. X is independent of the gravitational field strength Some points for students to take note: Gravitational field strength is not the same as gravitational force and hence should not be used interchangeably. Pressure is not the same on moon compared to on earth and hence this reasoning is also not acceptable.	[1]
8(a)(i) 8(a)(ii)	Angle x 1.5 = sin 50° /sin x X = 30.7° Angle y=30 +30.7 =60.7°	 [1] [1]

8(a)(iii)	N = 1/ sin c C = $\sin^{-1}$ (1/1.5) C = 41.8° The failure to gain full credit for this part was surprising as students should be well versed with the usage of this formula	[1]
8(b)	Total internal reflection	[1]
9(a)	I =0.48 – 0.16 =0.32 A	[1]
9(b)	E = 0.48 x 12 + 0.16 x 36 E= 11.5 V Majority of the students failed to consider the calculations in blue and hence was unable to obtain the EMF of the system. There are also students who thought EMF was the total current.	[1] [1]
9(c)	EMF: Amount of work done by the electrical source to move a unit charge round the entire circuit P.D: Amount of work done to move a unit charge across an electrical component. Note: EMF is not charge. There are many students who associated EMF with charge. These are 2 different physical quantities.	[1]
10(a)	The conducting ball will hit the positively charged plate and moves to the negative plate./It will oscillate between the two plates Once the ball touches the positive plate, all the electrons will flow out of the ball. It has a net positive charge and will move away from the positive plate and to the negative plate. Most students missed out on the explanation(in blue)	[1] [1]

10(b)	The plastic ball will remain attracted to the positive plate. /There will be no oscillatory motion The plastic ball is electrostatically induced and will be attracted. Since there is no flow of electrons out of the ball as it is not a conductor, it remains attracted. This part is poorly done, many students thought that the plastic ball will not even be attracted and there are also some students who thought that the plastic ball will also go through the oscillatory motion.	[1] [1]
10(c)	Q = It $8.5 \times 10^{-10} = I(1/4)$ $I = 3.40 \times 10^{-9}$ A Well done! But many students did not get the full credit as they either forgot to write the formula or give the units.	 [1] [1]
11(a)	The heated water at the bottom increase in volume and becomes less dense and rise. The cooler denser water at the top will sink. This forms a convection current. Well done. Most students mentioned about the changes in density(note if students only mentioned changes in volume, then they would not get the first mark) and creation of a convection current.	[1] [1]
11(b)	Prevent thermal energy loss via conduction and convection Do not accept: Reduce thermal energy loss via conduction and convection. Students should note that as convection and conduction requires a medium, there will be no thermal energy transfer via these two processes through a vacuum(no particles present) and hence should not use the word 'reduce' as this implies that there exists thermal energy transfer.	[1]
11(c)(i)	Q = mc(change in tempt)= 400 x 4.2 x (100-25) = 126000 J = 126 kJ There is a handful of students who are not familiar with the units of c given in the question and went to convert mass to kg instead and obtained the wrong answer for this part	[1] [1]
11(c)(ii)	400 x 20 x 60 = 126 000 + m (2250) m = 157.3 g = 157 g (3 s f) poorly attempted as they did not calculate the total energy supplied(in blue)	[1] [1]

11(c)(iii)	Dark colour is a good emitter of radiation and increase the rate of thermal energy loss.(reject if student uses 'absorber') Do not accept: Emitter of heat(use thermal energy or thermal radiation instead)	[1]
11(d)	Molecules come together/decrease molecular spacing Increase forces of attraction/form molecular bonds Increase in internal potential energy store Molecules move freely at high speeds to slide past each other Many students missed out on the 3rd point(in blue)	[1/2] [1/2] [1/2] [1/2]
12(a)	$^{241}_{95}Am \rightarrow {}^{4}_{2}\alpha + {}^{237}_{93}Np$	[1] [1]
12(b)	Gamma and beta will not produce enough ions/ionising power too weak Many students compared the difference in penetrative power instead and were not given credit.	[1]
12(c)	No of americium atoms remaining = 2×10^{14} $8 \times 10^{14} \rightarrow 4 \times 10^{14} \rightarrow 2 \times 10^{14}$ 2 half-lives eg 470 x 2 = 940 years) Not well done as many students did not even calculate the no of americium atoms remaining(1st point)	[1] [1] [1]
12(d)(i)	12 counts/min	[1]
12(d)(ii)	The radioactive sample has completely decayed	[1]
12(d)(iii)	Starting amount of radiation = 84-12 = 72 counts/min After one half life, count rate will be 72/2 +12 = 36 + 12 =48 counts/min Time = 13 minutes Not well done. There are students who left this part blank	 [1] [1]

13(a) (i)	The rotation of the magnet causes **a change in magnetic flux experienced** by the coil. According to faraday's law, this change in magnetic flux results in **induced EMF** and hence **induced current.** **The direction of the induced current reverses** as the magnet approaches and leaves the coil(according to **Lenz's law**) **Note: the words in bold has to be mentioned. Otherwise credit will not be awarded**	[1] [1] [1]
13(a)(ii)	Increase the strength of the magnet used Increase the number of turns of the coil Increase the speed of rotation of the coil (any two)	[2]
13(b) (i)	High voltage ensures that **low current** is transmitted as it minimises **power loss in** the cables. **Note: the words in bold has to be mentioned. Otherwise credit will not be awarded**	[1]
13(b) (ii)	P = IV P = 100 x 23000 V P = 2300000 W = 2.3 MW	 [1]
13(b)(iii)	Vs/Vp = Ip/Is 660000/23000 = 100/Is Is= 3.49 A	 [1]
13(b)(iv)	$P = I^2r$ $P= 3.49^2 x\ 2000 = 24.3$ kW	 [1]
13(b)(v)	Direct current sources will not be able to **create changing magnetic flux** which is required .	[1]
14(a)(i)	At the vertical position, the split ring **does not have any electrical** contact with the power supply and motor cannot work/no current passes through the coil at the vertical position	[1]
14(b)	The split ring commutator reverses the current when it goes past the vertical position. When the current reverses, the induced force on the coil also changes and allows the current to continue to turn in the same direction.	[1] [1]
14(c)	Upwards	[1]

14d(i)	Rotates for 50 seconds anticlockwise(or clockwise) Slows down and be stationary for another 50 seconds before it rotates again repetitively.		[1] [1]
14(d)(ii)	As the temperature increase, the resistance of the thermistor decreases. The PD across 500 Ω will increase Hence, the DC motor will operate at a higher power and rotates faster		[1] [1]
14(d)(iii)	5.7 x 2 = 11.4 V R = V / I = (20-11.4) / (5.7) = 1.51 Ω =1.5 Ω Nearest answer is 25 °C.	5.7 x 2 = 11 V R = V / I = (20-11) / (5.7) = 1.57 Ω = 1.6 Ω Nearest answer is 25 °C.	 [1] [1]