MARKING GUIDE FOR REGIONAL MOCK ENGINEERING SCIENCE 2O26
INTERMEDIATE LEVEL 5155 PAPER 2

1a,b,c

(1a)(i)C_2H_2 (acetylene or Ethyne)

(ii)$CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$

(iii) Using the equation above,

64g of CaC_2=74g of $Ca(OH)_2$

2.5g of CaC_2=$\frac{74x2.5}{64} = 2.89g$ of $Ca(OH)_2$

(b)(i) Quantity of electricity used Q=IXt

=2A x15x60=1800C

96000 C $\longrightarrow$ 1 F

1800 C $\longrightarrow$ $\frac{1800CX1F}{96000C}$=0.0188F

(ii) $Li^+ + e^- \longrightarrow Li$

1F $\longrightarrow$ 1mole

0.0188F $\longrightarrow$ $\frac{0.0188FXImole}{1F}$=0.0188F

(iii)$2H^+(aq) + 2e^- \longrightarrow H_2(g)$

2x96000C $\longrightarrow$ $24000cm^3$

1800C $\longrightarrow$ $\frac{1800X24000}{2x96000}$=$225cm^3$

C (i) Catalytic cracking breaks long-chain hydrocarbons into shorter, more useful ones using a catalyst. This process produces more branched ,cyclic and aromatic hydrocarbons, which have higher octane numbers. The petrol made from catalytic cracking is high-octane, meaning it burns smooth in engines and resists knocking.

(ii)Air pollution, global warming

1d.e.f

(d)(i) A strong acid is one that completely ionises in water. Examples, Hydrochloric acid(HCL), Sulphuric acid(H_2SO_4)

A weak acid is one which ionises partially in water. Example Ethanoic acid(CH_3COOH), Carbonic acid, (H_2CO_3).

(ii)$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(l)} + 2CO_2$

Carbon dioxide is given off.

(e))(i The atomic number is 56, and it represents the number of protons present in the nucleus of Barium.

(ii) Number of neutrons= 137-56=81

(iii)Number of electrons=56

(iv) Barium forms Ba^{2+} instead of Ba^+ because losing two electrons gives it the stable noble-gas configuration of Xenon, while losing only one electron leaves it in a less stable state. Therefore Ba^{2+} is much more energetically favourable.

(f)(i) Mass of Magnesium=15g

Molar mass of Mg= 24g/mol

Moles of Mg=$\frac{15}{24}$ =0.625mol

(ii) $2Mg + O_2 \longrightarrow 2MgO$

Mg:MgO=1:1

So, moles of MgO formed = moles of Mg used

Moles of MgO=0.625mol

(2)In OA, the velocity of the car increases, as time increases, therefore the car accelerates for a distance of 50m in 10seconds. In AB, the car moves with constant speed from 50m to 850m in 40 seconds. In BC, The speed decreases to zero, at a height of 900m in 20 seconds.

(ii) Average speed=$\frac{Total\ distance}{time\ taken}$ =50m/10s=5m/s

(ii) Speed of car,after 30s =5m/s+distance/time=5m/s+400m/20s=25m/s
(iii)Total distance travelled by car=900m
(b)(i) The principle of moments states that for a system in equilibrium, the total sum of clockwise moments must equal to the total sum of anti-clockwise moments about a particular pivot.
(ii) Total sum of clockwise moments about the pivot=(XN)(3m)=(3X)Nm
Total sum of anti-clockwise moments about the pivot
=(30N)(5m) +(40N)(2m)=230Nm,
Since the system is in equilibrium,
Total sum of clockwise moments about the pivot=Total sum of anticlockwise moments about the pivot
3X=230
X=230/3=76.6N
(iii) For a system in equilibrium, the resultant force should also be ON. Therefore the total sum of all the forces acting upward should equal to the total sum of forces acting downward.
R=30N+40N+77N=147N
(C) -Mass is a scalar quantity, while weight is vector quantity.
-Mass of a body is constant everywhere, whereas, the weight changes from *place to place*.
(3)(i)If a device that draws 8A is used, the fuse heats up, and melts, breaking the circuit to prevent damage.
(ii)Household circuits are wired in parallel, because this arrangement allows independent operation, and supports different power ratings.
(b)(i) When the key K, is opened,
Total resistance R=4+2=6Ω
Current I=E/R=12/6=2A
Therefore, the ammeter reading is 2A.
(ii)The p.d across 2 Ω, V=IR=2X2=4V
Therefore, the voltmeter reading is 4V
(iii) Combined resistance, when the key K is closed :
Combined resistance in parallel $R_p=\frac{6x4}{6+4}=2.4\Omega$
Total resistance $R_T=R_p+2\ \Omega=2.4+2=4.4\ \Omega$
(iv)Current $I=E/R_T=12/4.4=2.7A$
Therefore, the ammeter reading, when the key, K is closed is 2.7A
(C)(i) 1kWh=1000 Wx3600 s=$3.6x10^6$J
(ii)Total power=3000 W+1000 W= 4000 W
Total energy consumed= 4000WX10h=40,000Wh=40 kWh
1kWh=75frs
40kWh=40 x 75=3000 frs
(4)(a)(i) -Plastics are poor conductors of electricity, making them excellent insulators
- Plastics are resistant to corrosion
(ii)Thermoplastics soften or melt when heated and harden again when cooled while thermosets harden permanently when first heated and shaped.
(iii)Thermo plastics can be recycled because their molecular structure consists of long chains that are not cross-linked, the melted plastics can therefore be ─reshaped into new products. Thermosets cannot be melted, they cannot be reshaped or remoulded, making recycling impossible.
(b)(i)Stress=F/A=$\frac{4F}{\pi d^2}$=4(100)/3.14(.24x10^{-4})^2=2.2x10^9 Nm^{-2}
(ii)Strain=$\frac{e}{l}$=0.04/1.76=2.3x10^{-2}
(iii) Modulus of elasticity=$\frac{Tensile\ stress}{Tensile\ strain}=\frac{2.2x10^9}{2.3x10^{-2}}=0.95x10^{11}Pa$
C (i) Tension(T) in the wire =weight of the mass

g=10 m/s^2

T=mg=5x10=50 N

(ii)The extension in the wire is x=4.0mm=0.004 m

Hooke's law, F=kx,

k=F/x=50/.004=12,500 N/m

(5)(a)(i) Work done = Fs=250X10=2500 J

(ii) Useful work done=g.p.e gained=mgh=50x10x4=2000 J

(iii) Efficiency=$\frac{Useful\ work}{Total\ work}$x100%

=$\frac{2000}{2500}$x100%=80%

(iv)The efficiency is less than 100%, because of the friction between the bag and plank

(b)Mass, m=100 kg, initial speed, u=20 mls, final speed,v= 60 mls,time =14.5s

(i)Change in kinetic energy= final kinetic energy-Initial kinetic energy

K.E=$\frac{1}{2}$mv^2

Change in KE $\Delta(KE)$ = $\frac{1}{2}$(100)(60^2)- $\frac{1}{2}$(100)(20^2)=180,000J-20,000J=160,000J

(ii) Average power=$\frac{\Delta KE}{t}$ = $\frac{160000}{14.5}$= 11,034W

(c)(i)Sun(solar energy). The sun provides energy in the form of sunlight. Energy is obtained from the sun by using solar panels which contain photovoltaic cells that convert sun light directly to heat.

-Wind energy is obtained using wind turbines. The wind blows and pushes the blades of a wind turbine. The rotating blades turn a shaft inside the turbine. The shaft spins a generator, which produces electricity.

(d)(i) A=toxic substance, B=high voltage or danger

(ii) –Keep a safe distance from the equipment area

-Do not touch any wires, switches or metal parts nearby

(6)(a)(i) This is because the newspaper wrappers , modified or layered with other materials provide insulation and grease soak –through. The inner layer also traps steam and moisture.

(ii) The bottle of water cracks when forgotten in the freezer because, water expands when freezes. This is because the water molecules arrange inti an open hexagonal crystal structure(ice) which occupies more volume than liquid water.

(iii)Water needs much more energy to become steam than to become ice because melting only requires loosening some hydrogen bonds so,less energy is needed (3.36x10^{5}J). Boiling requires breaking all hydrogen bonds , and separating molecules apart, doing work against the atmosphere, which takes much more energy(2.26x10^{6}J/Kg).

(b)(i)Power=5 kW=5000 W, Time =2.5minutes=150 s, Lv=2.3x10^{6}J/Kg

E=Pxt=5000x150=750000 J

m=E/Lv=$\frac{750000}{2.3000000} = 0.32kg$

(ii)-Presence of impurities, dissolved salts, sugar.

-High external pressure.

(c)(i)Nor gate

(ii)

A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0

(7)(a)(i) Angle of incidence=$90° - 43° = 47°$

(ii) n=1.5

$n=\frac{sini}{sinr}$, $r=\sin^{-1}\frac{sini}{n}=\sin^{-1}(\frac{sin47}{1.5})$

r=29.2°

(iii)Total internal reflection is not possible for light passing from air to glass, because air is less dense than glass.

(iv) Designing lenses and optical instruments. Knowing a material's refractive index helps engineers to design lenses for cameras, microscopes and telescopes.

(v) Advantages of Optical fibres

- Higher band width
-Lower signal loss(attenuation)

Disadvantage of optical fibres

Higher installation and repair cost

(b)(i) h_0=0.2m, u=0.5m, focal length, f=0.1m

$\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$

1/0.1=1/v +1/0.5

V=1/8=0.125m

Therefore, image distance, u=0.125m

(ii)Magnification (m)=v/u=0.125/0.25=0.25

Since real images are inverted, the m= -0.25. This means that the image is inverted and ¼ the size of the object.

(c)(i)The transformer is a step down transformer.

(ii)V_P=240V,V_s=6V, I_s=5A

Since transformer is 100% efficient, Power in put=power output

$I_pV_p=I_sV_s$

$I_p=\frac{5AX6V}{240V}$=0.13A.

(8)(a)(i) The current flowing through the galvanometer can be increased by:

-Increasing the speed of motion of the bar magnet. This will increase the rate at which field lines are cut, hence the emf and the current will increase.

-Increasing the number of turns in the coil. Increasing the number of turns also increases the region coil through which magnetic field lines can pass. This leads to an increase in the number of field lines crossing per unit time ,and hence the induced emf and current will increase.

(ii)End X is the north pole.

(b)(i) Points A and E are in phase. This is because they occupy identical positions and are moving in the same direction.

(ii)The distance between points 0 and C, or the distance between points A and E. This is because, a wavelength represents one complete cycle of the wave, or it is the distance between two consecutive crests or troughs.

(iii)V=20m/s , $1wavelength$=0.8m

Frequency=speed/one wavelength=20/0.8=25Hz

(iv)A wave pulse is a single transient disturbance traveling through a medium as an isolated wave while a wave train is a continuous group of waves travelling through a medium.

(c)- Recycling and waste management

-Use of pollution control devices