PARALLELOGRAM LAW

1 **(a)** State the factors which completely describe a vector quantity.

.....

..... [1]

(b) An aeroplane is flying towards the east in still air at 92 m/s. A wind starts to blow at 24 m/s towards the north.

Draw a vector diagram to find the resultant velocity of the aeroplane. Use a scale of 1.0 cm = 10 m/s.

resultant speed = ...

angle between resultant and easterly direction = ...
[5]

[Total: 6]

MARKING SCHEME

(a)	Size / magnitude (NOT distance) and direction	B1	
(b)	Vectors towards East and North with arrows correct by eye	B1	
	Complete triangle or rectangle for candidate's vectors	B1	
	Resultant with correct arrow	B1	
	Resultant 94 to 96 m/s by scale OR 95 m/s by calculation *Unit penalty applies	B1	
	Angle measured 13.5° – 15.5° OR 15° by calculation *Unit penalty applies	B1	**[6]**

*Apply unit penalty once only

2 **(a)** **(i)** Mass is a scalar quantity.

State another scalar quantity.

.....

(ii) Force is a vector quantity.

State another vector quantity.

.....
[2]

(b) A boat is floating on still water.

The mass of the boat is 290 000 kg. A resultant force of 50 kN acts on the boat.

Calculate the acceleration of the boat.

acceleration = ...[3]

(c) Fig. 2.1, not to scale, shows the view from above of the boat, now on a fast-flowing river. The boat accelerates.

Two forces are shown acting on the boat. The resultant of these forces is at right angles to the river banks.

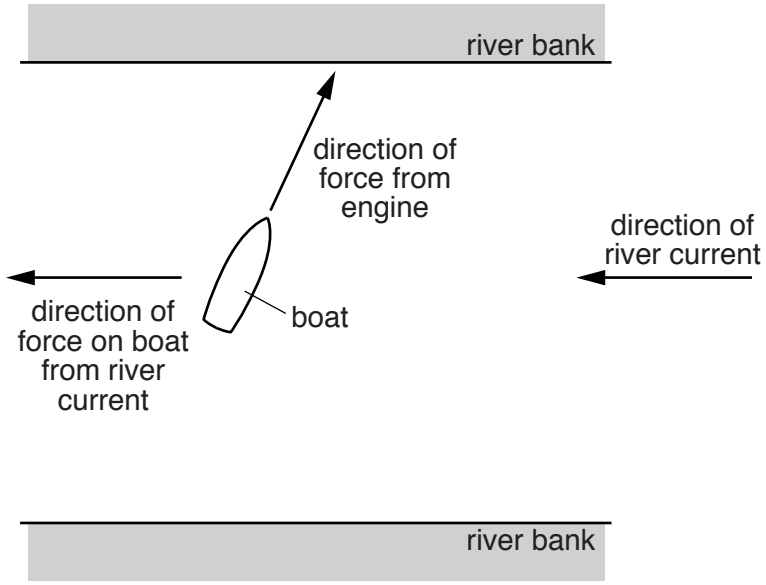

Fig. 2.1 (not to scale)

Fig. 2.2 is an incomplete vector diagram of the forces acting on the boat.

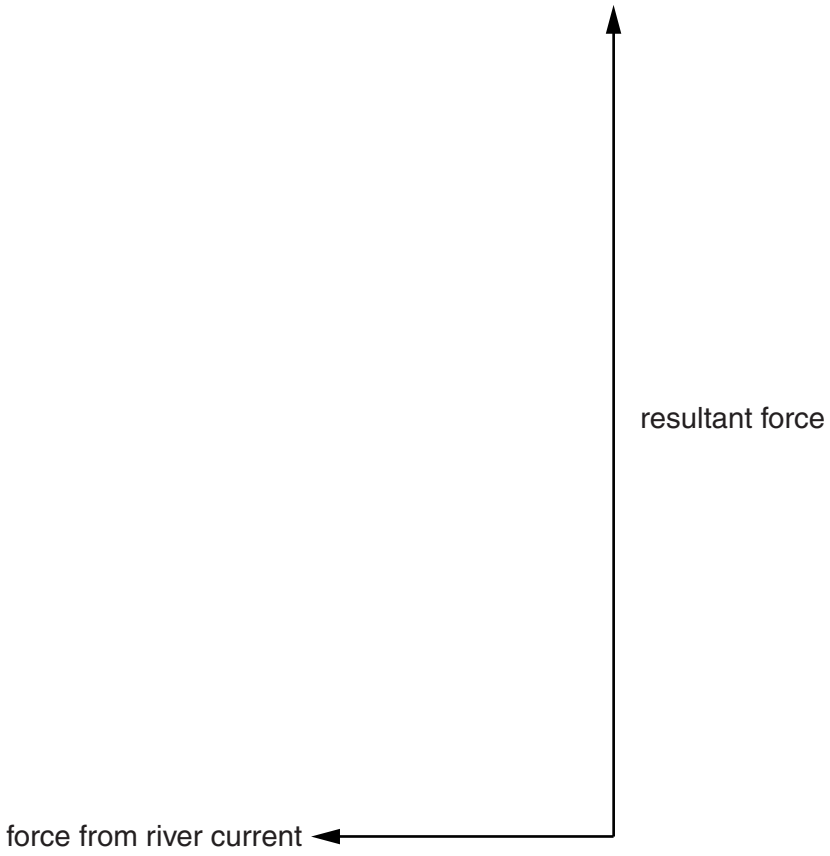

Fig. 2.2

The force from the river current is 80 kN.

(i) Determine the scale that has been used in the vector diagram.

scale is .....

(ii) On Fig. 2.2, complete the vector diagram to determine the magnitude and direction of the force from the engine. Measure the angle between the direction of the current and the force from the engine.

magnitude of force from engine = ...

angle = ...
[4]

[Total: 9]

MARKING SCHEME:

(a)	**(i)**	any scalar quantity other than mass	B1
	(ii)	any vector quantity other than force	B1
(b)		F = ma in any form OR (a =) F / m	C1
		50 000 / 290 000 OR 50 / 290	C1
		a = 0.17 m / s^2	A1
(c)	**(i)**	1 cm: 20 000 N / 20 kN	B1
	(ii)	triangle completed	B1
		230 000 N OR 230 kN in range 220 000 N – 240 000 N / 220 kN – 240 kN	B1
		by calculation: 110°	
		OR by measurement: 108° – 112°	B1

[Total: 9]

3 **(a)** In an accident, a truck goes off the road and into a ditch. Two breakdown vehicles A and B are used to pull the truck out of the ditch, as shown in Fig. 4.1.

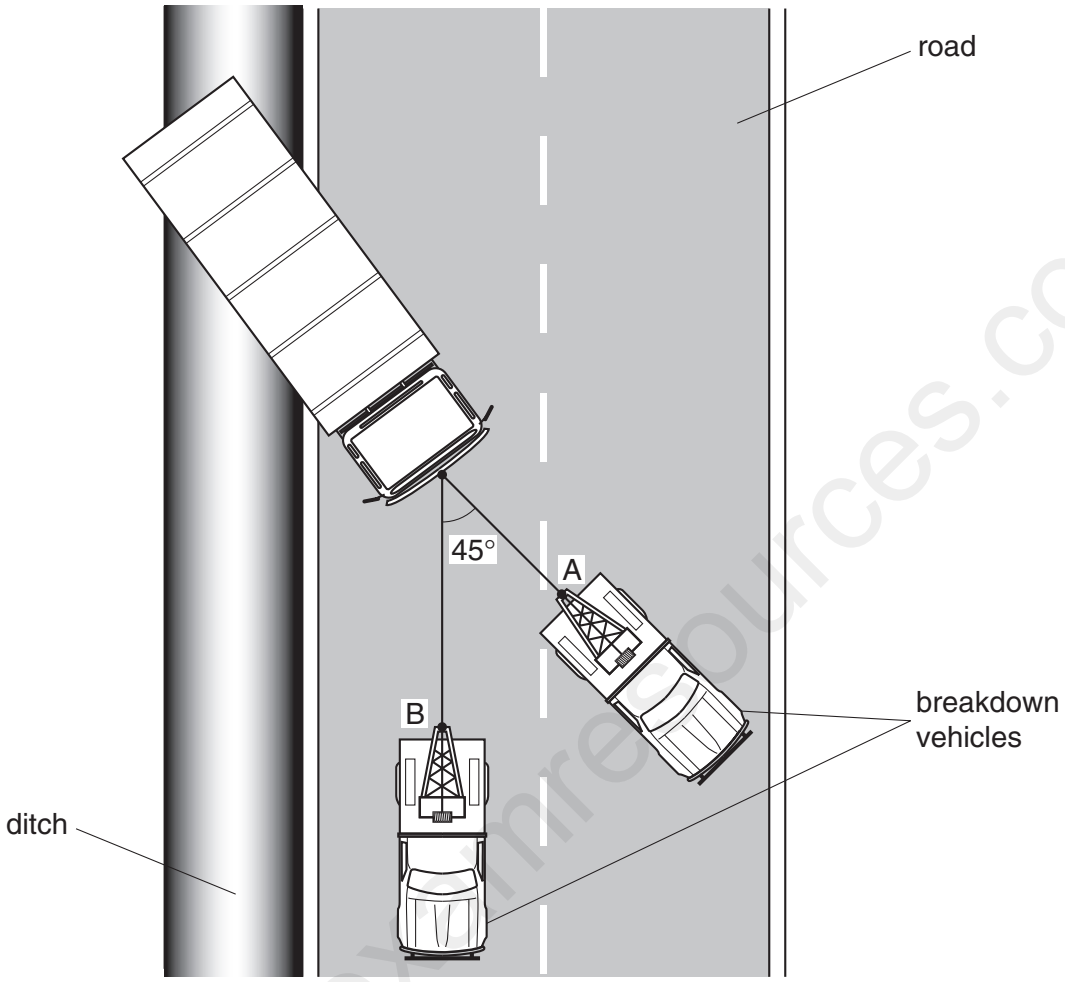

Fig. 4.1

At one point in the rescue operation, breakdown vehicle A is exerting a force of 4000 N and breakdown vehicle B is exerting a force of 2000 N.

(i) Using a scale of 1 cm = 500 N, make a scale drawing to show the resultant force on the truck.

[4]

(ii) Use your diagram to find the magnitude and direction of the resultant force on the truck.

magnitude of resultant force = ...

direction of resultant force = ... to direction of road [2]

(b) (i) State why the resultant force is an example of a vector quantity.

..... [1]

(ii) Give an example of a vector quantity that is not a force.

..... [1]

[Total: 8]

(a)	**(i)**	(note: diagram may be drawn in any orientation)		
		sides correct length, by eye	B1	
		forces drawn at 45°, by eye	B1	
		parallelogram completed	B1	
		correct diagonal drawn / correct resultant if intersecting arcs shown	B1	
	(ii)	magnitude: between 5500 N and 5700	B1	
		direction: between 28° and 32°	B1	
(b)	**(i)**	it has direction (as well as magnitude)	B1	
	(ii)	any example which is clearly a vector	B1	[8]

4 **(a)** **(i)** State one similarity and one difference between vector and scalar quantities.

similarity .....

difference .....[2]

(ii) Give an example of each quantity.

vector quantity .....

scalar quantity .....[2]

(b) Fig. 3.1 is an overhead view of two tractors pulling a tree trunk.

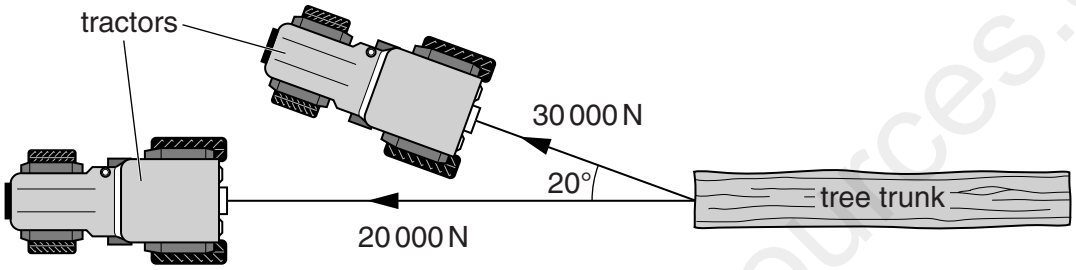

Fig. 3.1

The force exerted by each tractor is indicated in the diagram.

In the space below, carefully draw a scale diagram to determine the resultant force on the tree trunk. State the scale you use.
Write down the magnitude of the resultant force **and** the angle between the resultant force and one of the original forces.

magnitude of resultant force = ...

direction of resultant force = ...
[4]

[Total: 8]

(a)	**(i)**	(both have) magnitude o.w.t.t.e.	B1	
		(only) vector has direction	B1	[2]
	(ii)	valid example of vector quantity e.g. displacement, weight, force, velocity	B1	
		valid example of scalar quantity e.g. distance, length, time, pressure, mass, energy accept height	B1	[2]

(b)	each vector to scale and correct angle, larger vector clockwise by acute angle from smaller		
	parallelogram or correct two sides of triangle	B1	
	resultant drawn correct, from his parallelogram or his sides of triangle	M1	
	magnitude 4.5 – 5.4 $\times 10^4$ N, accept 1 sig. fig. if exact AND direction 4 – 12° from 3 $\times$ 10^4 N force OR 8 – 16° from 2 $\times$ 10^4 N force accept values from diagram	A1	[4]